1994 FISHERY MANAGEMENT PLAN

UPDATE FOR LAKE O'NEILL

CAMP PENDLETON, CALIFORNIA

AFR-FRO-95-02

PREPARED FOR:

ASSISTANT CHIEF OF STAFF, ENVIRONMENTAL SECURITY
ENVIRONMENTAL AND NATURAL RESOURCES OFFICE
MARINE CORPS BASE
CAMP PENDLETON

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INTRODUCTION

The Marine Corps Base, Camp Pendleton, California, (Base) maintains a natural resource program for protecting, conserving, and managing fish and wildlife resources under their jurisdiction. Providing quality recreational opportunities for military personnel and their families is an important component of Natural Resources management activities on the Base. Although active wildlife management programs for promoting wildlife related activities exist, fishery related efforts have been minimal.

The Assistant Chief of Staff, Environmental Security (ACS, ES) recognized the need for coordinated, scientifically based fishery management planning and funded the U.S. Fish and Wildlife Service (USFWS) through its Coastal California Fish and Wildlife Office to develop fishery management options for selected Base waters. Lake O'Neill is the largest body of water on Camp Pendleton and offers the potential for significant recreational opportunities easily accessible to Base personnel. This potential makes it the logical choice to develop a "quality" fishing experience to complement its other values.

The specific purposes of USFWS activities on Lake O'Neill were to inventory the current fishery resources of the lake, determine the suitability of the lake for fish, and update the fishery management plan (FMP) developed in 1993 to improve its recreational fishing value.

Lake O'Neill and vicinity is an important recreational area on Camp Pendleton. It offers fishing, bird watching, camping, picnicking, boating, jogging, and other recreational opportunities. During the winter drawdown, the exposed mudflats of the lake attract many shorebirds because of its available food supply and protected inland location. Winter storms sometimes force shorebirds inland and the lake offers a safe haven. Some waterfowl may nest and rear young in the lake area but their numbers are unquantified. The lake also provides habitat for other bird species and numerous mammals.

Some of the information in this report is duplicated from the 1993 FMP for Lake O'Neill. Updated information includes water quality and biological collection with associated analysis and recommendations.

The appropriateness of USFWS involvement on Camp Pendleton is delineated through the authorizations granted by the Sikes Act (P.L. 86-797) as amended and the Fish and Wildlife Coordination Act (P.L. 85-624) as amended. The work is also consistent with the USFWS Recreational Fisheries Policy.

STUDY AREA

Camp Pendleton is located along the southern California coastline approximately 84 kilometers (km) north of San Diego (Figure 1). The boundaries of the Base enclose approximately 50,586 hectares of a variety of habitats including; coastal strand, salt water estuary/fresh water marsh, riparian woodland, coastal sage scrub, oak woodland/savannah, annual and perennial grassland, and chaparral. Coastal plain areas of southern California exhibit a subtropical climate characterized by warm, dry summers, moderate winters, and frequent fog. Temperatures are moderate, with an average monthly maximum temperature of 23 degrees centigrade (°C). The coldest month is January and the warmest is September. Temperatures are rarely freezing and few days exceed 32 °C. Precipitation averages 34.5 centimeters (cm) (13.6 inches) per year, with most (84%) occurring between November and March. January is the wettest month, while July is the driest (Figure 2).

Lake O'Neill is a manmade impoundment of about 50 surface hectares located on Fallbrook Creek. It first stored water in 1883 when it was part of Rancho Santa Margarita, a large cattle ranch. Water in the lake was used to raise crops and support livestock. The lake obtains its waters from two sources, Fallbrook Creek and a diversion from the Santa Margarita River.

The U.S. Government acquired the "Rancho" (and its associated water rights) during 1942-1943 for a military installation. Since that time, Lake O'Neill has primarily been utilized as a storage site for water utilized for flood control measures and recreation. Full capacity of the lake is about 1.63 million cubic meters (m^3) (1,200 acre feet) and can be characterized as a shallow, eutrophic type water, with a high shoreline to volume ratio. Maximum depths occur near the dam. Following dredging near the dam in 1992, the minimum pool elevation was 28.3 meters (m) above mean sea level with dead pool storage at 17% of capacity (270,000 m^3 or 200 acre feet). At capacity, the maximum depth would be about three m. Surface water temperatures range from about 5° C in the winter, to 30° C in summer, although comprehensive year-round data is lacking.

The shallow waters of the lake, especially in the upper end, are conducive to the growth of aquatic vegetation along the shoreline and in other areas. Considerable growths of cattail (*Typha sp.*), bulrush (*Scirpus sp.*), water lily (*Nuphar sp., Nymphaea sp.*) and burrhead (*Echinodorus sp.*) are present. A map of the lake, developed in 1992, describing aquatic plant distribution and significant study areas is shown in Figure 3.

Fish species known to be present include: Largemouth bass (*Micropterus salmoides*); Black Crappie (*Pomoxis nigromaculatus*); Brown bullhead (*Ictalurus nebulosus*); Channel catfish (*Ictaluras punctatus*); and Golden Shiners (*Notemigonas crysoleucas*).

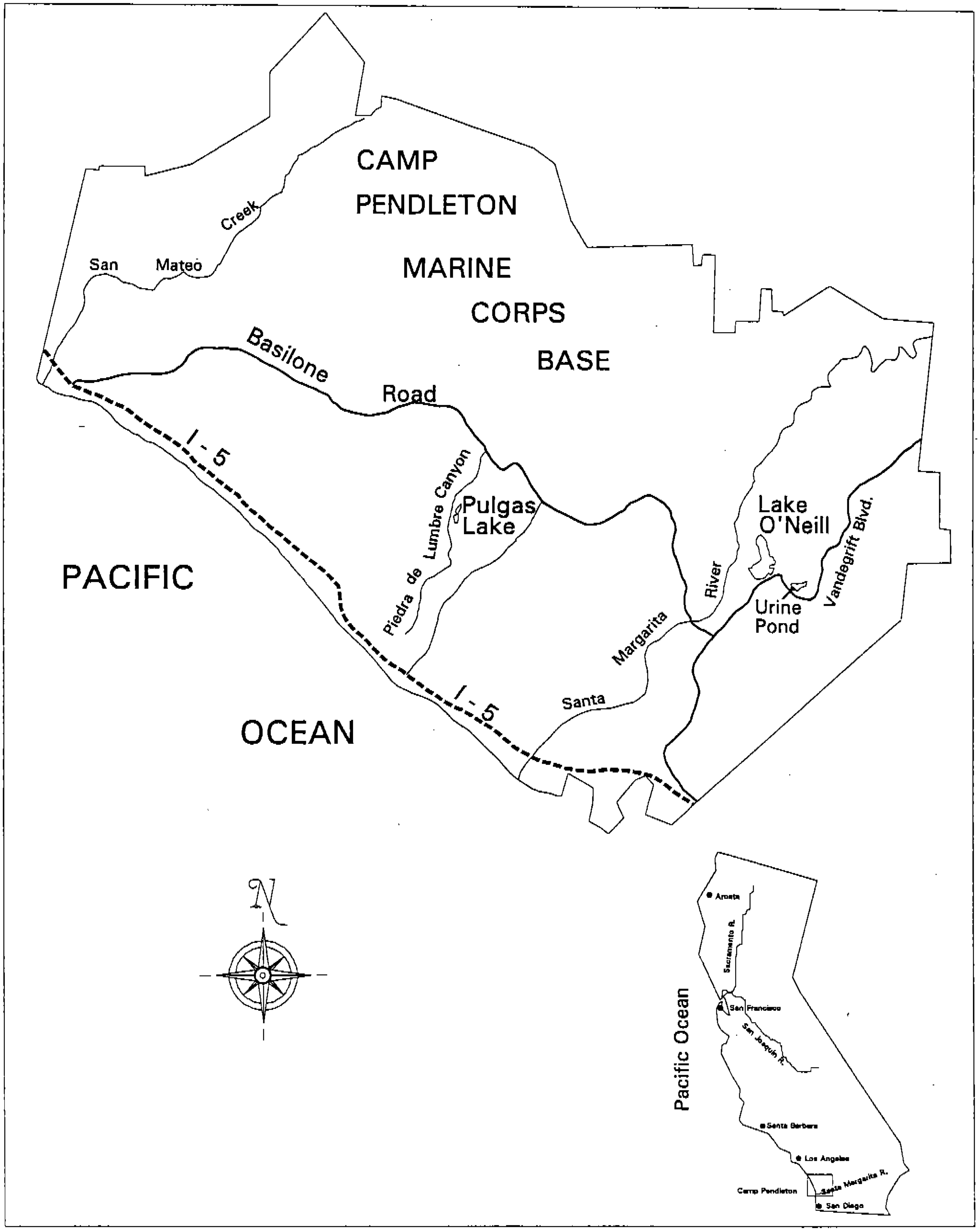


Figure 1. Camp Pendleton Marine Corps Base map and location within California.

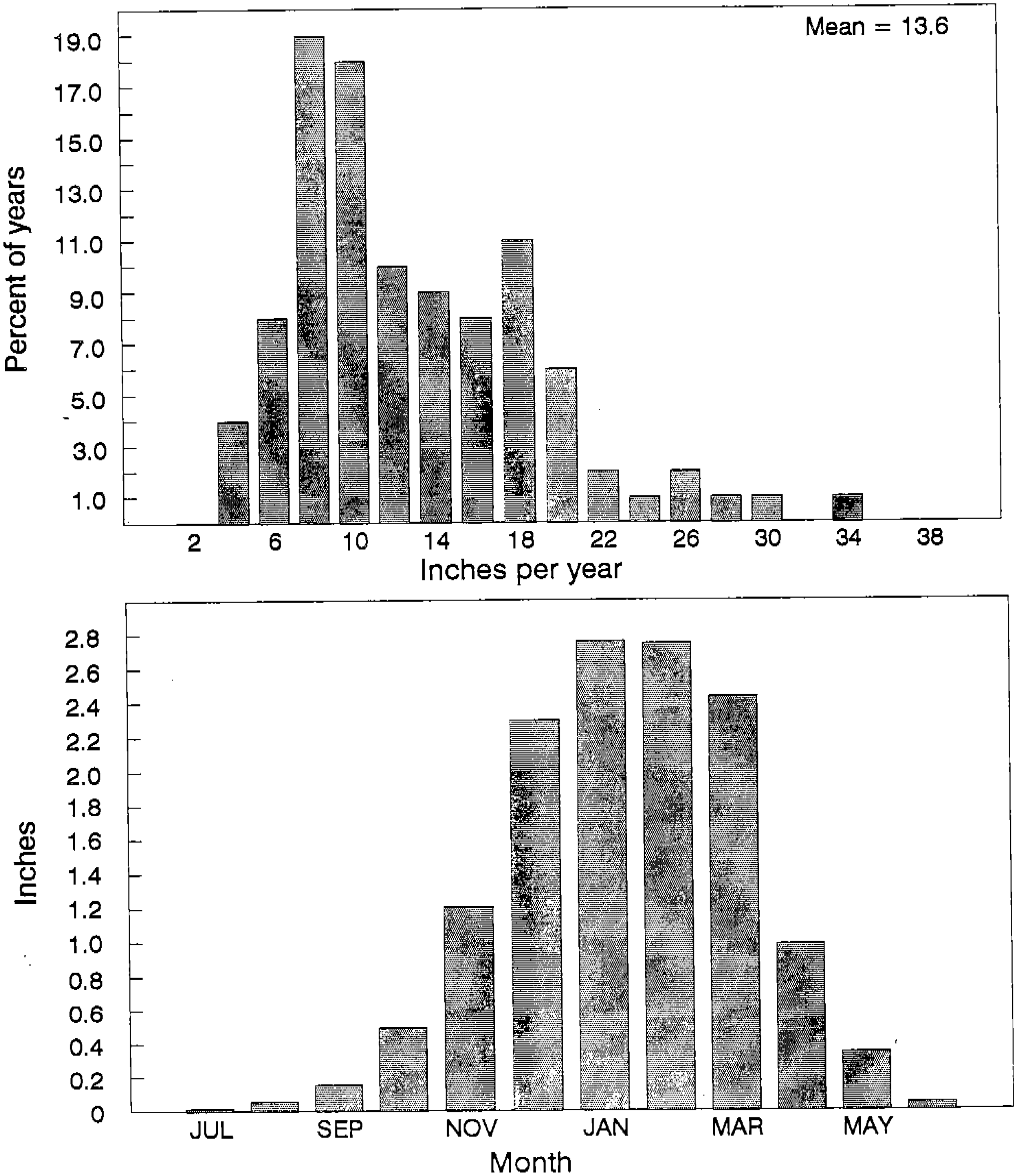


Figure 2. Mean local precipitation collected near Lake O'Neill from 1876-1990. The bottom graph is the average monthly precipitation and the top graph is total annual precipitation.

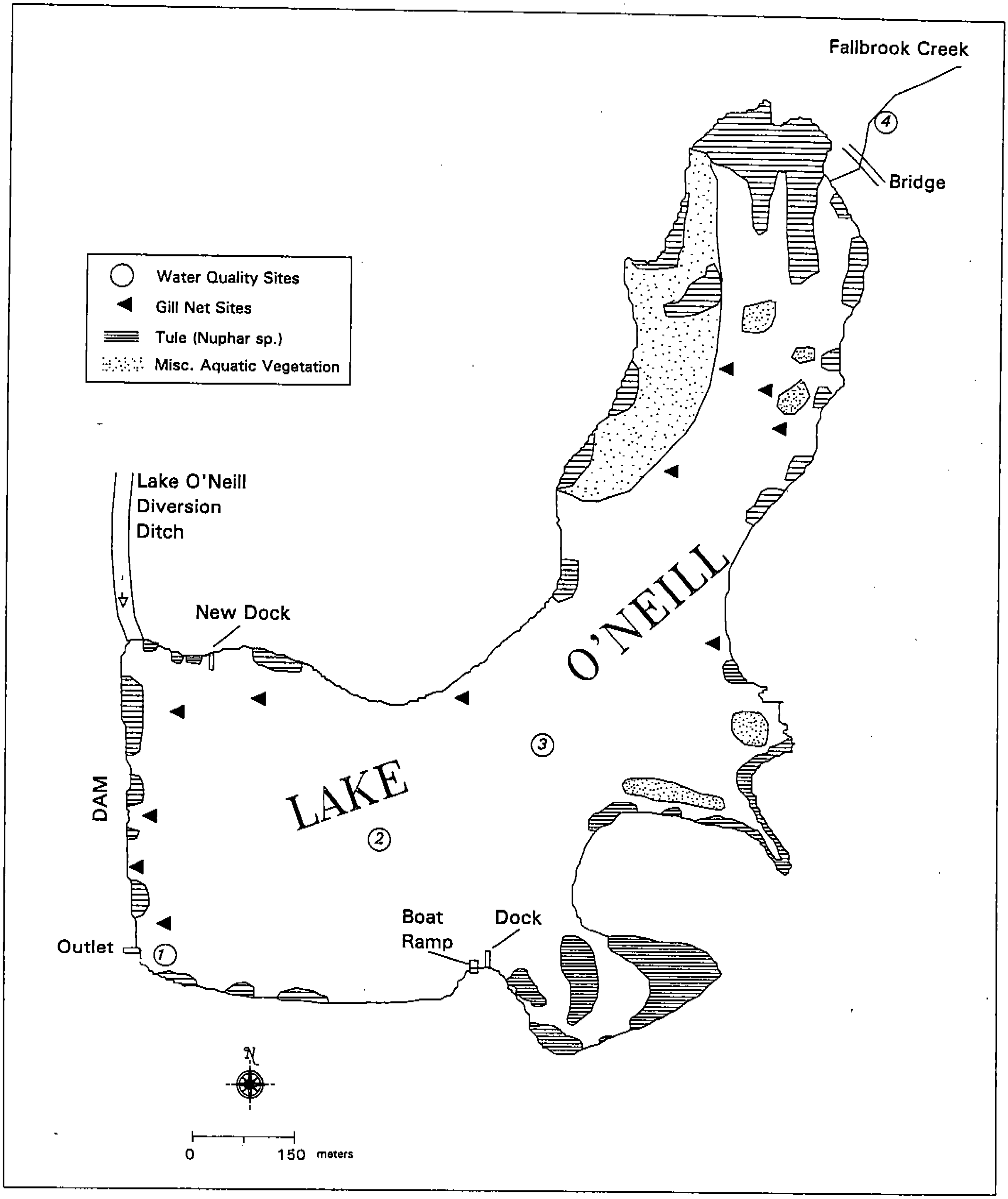


Figure 3. Lake O'Neill, showing sample sites and areas of aquatic vegetation.

METHODS

Hydrology/Water Quality

Santa Margarita River discharge data were obtained by USFWS in 1992 from U.S. Geological Survey (USGS) water supply publications dating back to 1960. The current USGS gauge (#11046000) is located at Ysidora near the Basilone Road Bridge. This site is below the diversion to Lake O'Neill and has been in operation since 1980. The previous gauge site was 10 km downstream and the records are not equivalent to post 1980 data.

Data on Lake O'Neill ditch diversions from the Santa Margarita River and Fallbrook Creek discharges were obtained by USFWS in 1992 from the Camp Pendleton ACS, ES, Resource Management Division. That office also maintains precipitation, air temperature, and some water quality records used in this report.

Current water quality data for Lake O'Neill were obtained by sampling at three sites in June 1994. These sites were the same locations sampled by USFWS in January 1992. Water samples were collected at the surface and on the bottom using a Lamotte water sampler. Bottom samples were collected allowing clear lake water only to enter the sampler without any muddy bottom debris. Water samples were immediately taken to the Quality Assurance Laboratory in San Diego for analysis. Each sample was tested for a variety of factors, including; hardness, nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, total-phosphate-P, ortho-phosphate-P, total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), total alkalinity, bicarbonate, silicon, sulfate and carbon dioxide. A complete list of specific analysis requested and analysis methods utilized by the lab are shown in the lab report (Appendix A).

Temperatures and dissolved oxygen (D.O.) levels were taken by USFWS personnel utilizing a YSI Model 51B probe. These measurements were taken on the surface, at each meter depth and on the bottom. Measurements were taken at all three sites previously identified in June and September 1994.

A Cole-Parmer DSPH-1 handheld meter was used to measure pH and conductivity on the surface and the bottom. Conductivity values were standardized to ambient water temperature with the formula, $\delta_a=\delta_s/\langle 1.02^{(T_s-T_A)}\rangle$ where, δ_a = ambient conductivity (micromhos/cm); δ_s = specific conductivity (micromhos/cm); T_s = instrument calibration temperature (25° C); and T_A = ambient water temperature (°C) (Kolz and Reynolds, 1989). Samples were collected with a LoMotte water sampler at the same three sites in June and September 1994.

Biological Collections

Fish sampling was accomplished by use of gill nets. Each net was 1.8 m high and 38.1 m long with 5 panels, each 7.6 m long. The stretched mesh graduated in size with each panel; 2.5 cm, 3.8 cm, 5.0 cm, 6.4 cm, and 7.6 cm. Each net had a weighted bottom line and a floating top. The end of the net with the smallest mesh was secured to the shore and stretched (perpendicular to the shore) into the lake. Site selections were based on the probability of catching fish and the length of time since the area was last sampled. Because fish learn to avoid nets that are set in the same area on consecutive days, nets were set in areas that had not been sampled for at least two days.

Two gill nets were fished both day and night on June 6 to 7, September 23 and September 26 to 28, 1994. The nets effectively reached from the bottom to within 0.5 to 1.5 m of the surface. Net sample sites are shown in Figure 3.

Nets were fished from early evening (around 1700 hours) until about 0830 and reset at 0930 and fished until about 1600 hours each day.

Nets were retrieved in the morning and evening starting at the end farthest from the shore. Fish were removed from the net and immediately placed in a container of fresh pond water. After all fish were removed from the net we measured total length (mm), weight (g) and took a scale sample. Live fish were released back into the lake immediately after measurements were taken.

Total length data was entered into a computer data base. These data were used to create length frequency histograms to aid in age class determinations.

Scales were taken from the first ten fish of each species within every 10 mm size group (i.e. 60 to 69 mm, etc.). Scales were cleaned and mounted on slides with cover slips. A microfiche card reader was used to magnify the scale image for visual interpretation of age for individual fish.

We chose the method of proportional stock density (PSD) to measure the quality and relative balance of the fishery community. PSD is measured by dividing the number of quality-size fish by the number of stock-size fish. Minimum quality length falls within 36 to 41% of the world record length. Minimum stock length falls within 20 to 26% of the world record length (Flickinger, 1985, personal communication, pers. comm.).

RESULTS AND DISCUSSION

Water Management

Lake O'Neill receives inflow from two sources; Fallbrook Creek and through the diversion ditch from the Santa Margarita River. Prior to 1983, it also received treated sewage effluent from Urine Pond (Cates and Shaw, 1993) and from Fallbrook Sanitation District via Fallbrook Creek. The Sanitary District discharge was connected to an ocean outfall in 1983 and a pipeline was installed to route the Urine Pond discharge past Lake O'Neill that same year (Malloy, personal communication, August 1994). The basic water right as adjudicated in United Stated versus Fallbrook Utility District, et al. (U.S. District Court Southern District of California No. 1247-SD-C) is stipulated as 1100 acre-feet (296,000 m^3) plus 100 acre-feet for dead storage. Additionally, water may be taken from the river throughout the irrigation season, in quantities sufficient to off set seepage and evaporation losses for the purpose of keeping the lake filled to capacity.

Lake O'Neill is operated as a flood control reservoir to protect the Naval Hospital Road across the dam and downstream facilities from the heavy runoff that enters the Base via Fallbrook Creek during storm events. The fall-winter drawdown is scheduled in accordance with long-range weather forecasts and adjusted for short-term events as needed in order to meet anticipated runoff capture requirements.

Water is diverted from the Santa Margarita River via the Lake O'Neill ditch, generally between November and the end of March (Cates and Shaw, 1993). The rate of withdrawal may not exceed 0.57 cubic meters per second (cms). Water entering the ditch can either enter the lake or be diverted into groundwater recharge basins. Peak river diversions usually occur from January through March. Very little water is typically taken from May through November, and December diversions have only occurred five out of the last 30 years (Figure 4). Since the early 1960's water from Fallbrook Creek has amounted to more than 50% of the total flows into the lake.

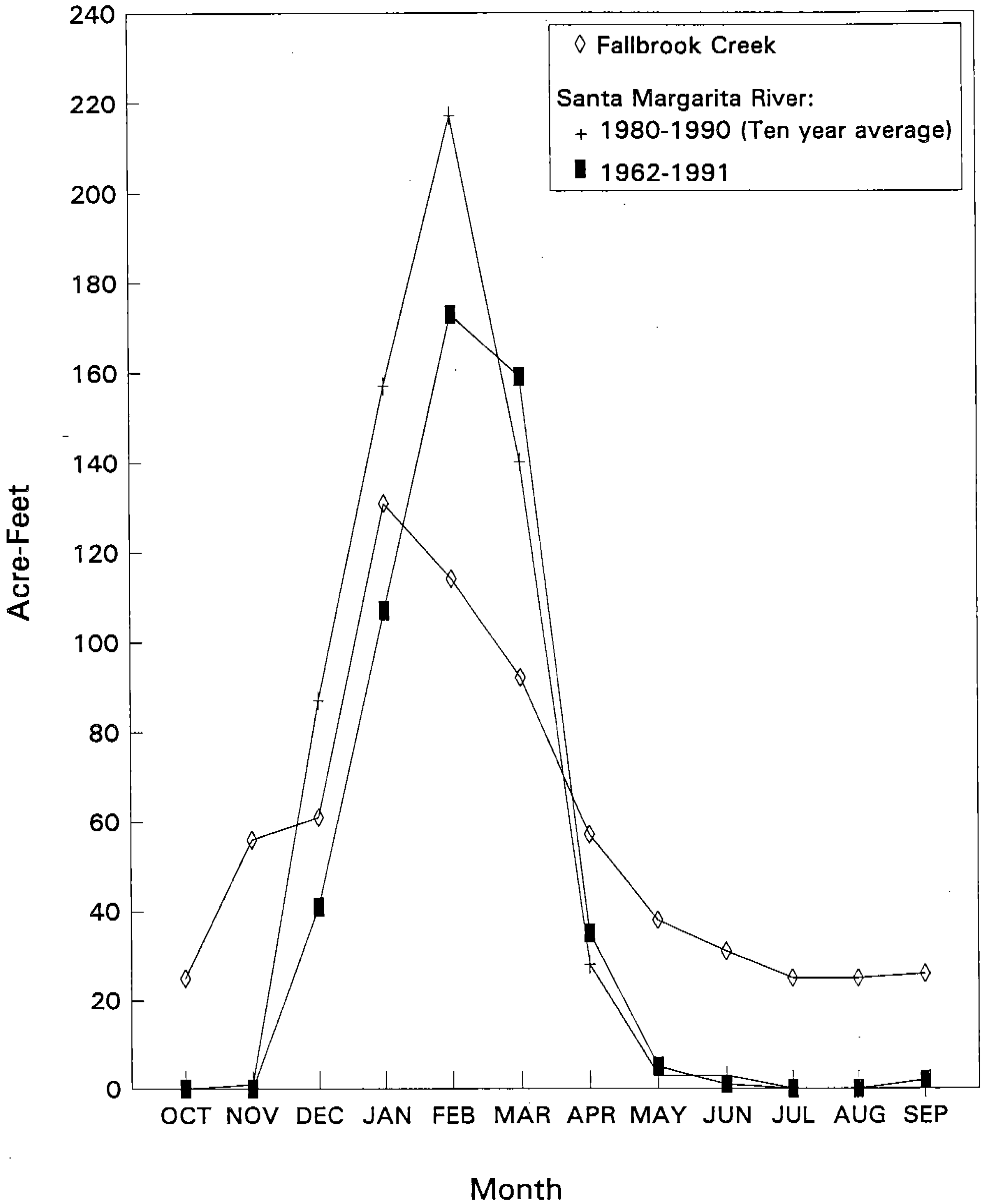


Figure 4. Average monthly discharge of Fallbrook Creek and Santa Margarita River diversions into Lake O'Neill.

The lake, typically, is full by April and remains near capacity until about mid-November, when the outlet valve at the dam is opened and water is allowed to drain (Cates and Shaw, 1993). The water released, gradually recharges the groundwater supply downstream of the lake. Following the fall and winter rains, the river begins flowing again after normally being dry from July to October (Figure 5). Although average monthly flows indicate water is available during the June to October period, this is generally not the case, and is a result of unusual flows (summer storms) in some years (Malloy, Personal Communication July 1994). High flow events in the river can carry substantial amounts of debris and silt downstream, as a result, it is common practice to avoid diverting water into Lake O'Neill during the initial high flow days. Despite this practice, a considerable amount of silt has accumulated in the ditch and has also created a "delta" where the ditch enters the lake. The dredging in 1992 was aimed at removing this silt accumulation in the lake to improve depth and storage characteristics (Cates and Shaw, 1993).

Most of the lake has a relatively flat topography with fine-grained bottom sediments. This provides little structural habitat for fish until lake levels reach near capacity. Structural habitat complexity for fish increases as the tule patches and other aquatic vegetation becomes wetted. A large part of the upper lake was enveloped with aquatic vegetation at the time of our sampling in 1994. Nearly all of this vegetation is exposed and dried following the yearly drawdown of water levels (Cates and Shaw, 1993). At capacity pool evaluation, the vegetation covers more surface area of the lake than shown in Figure 3. Figure 3 is a map which was developed during the draw down period in 1992. It is not clear if a similar pattern of draining and refilling the lake has been followed each year. Base records do indicate that a flood in 1978 washed out the diversion weir in the Santa Margarita River. Until the weir was rebuilt in 1982, the Base lost the ability to divert water into the lake. During this time Fallbrook Creek and the flow from Urine Pond filled the lake. A pipeline was completed in 1983 which diverted effluent away from Lake O'Neill. There has not been a consistent drain/fill pattern since the 1983 modification. Flow from Urine Pond into Lake O'Neill is still possible during high runoff events or mechanical emergencies which disrupt normal sewage plant and discharge operations (Malloy, pers. comm.).

Water Quality

Water quality results from samples taken in Lake O'Neill on June 9, 1994 are shown in Table 1. Water temperatures, dissolved oxygen, pH and conductivity levels from samples taken on June 9, and September 26, 1994 are shown in Table 2.

Surface and subsurface temperatures in June 1994 reached 25° C (Table 2). Preferred temperatures for largemouth bass (24° to 29° C), bluegill (16° to 27° C), black crappie (18° to 29° C), and channel catfish (21° to 27° C) indicate Lake O'Neill summer temperatures should be favorable for these species (Reininger, 1984). Water temperatures observed at all sample sites were suitable for warmwater fish but were quite marginal for trout. Trout can tolerate temperatures in the neighborhood of 26° C, but prefer 10° to 16° C (Piper, et al., 1986)

D.O. is critically important in determining the suitability of waters for fish. Minimum limiting D.O. concentrations for each fish species depends on a wide variety of physical and chemical factors under which the fishes are capable of survival. The minimum limiting D.O. concentration is not an absolute value. It is dependent upon temperature, atmospheric pressure and the related metabolic rate of the fish. The inherent metabolic rate associated with age, health of the fish, especially health of gill tissue

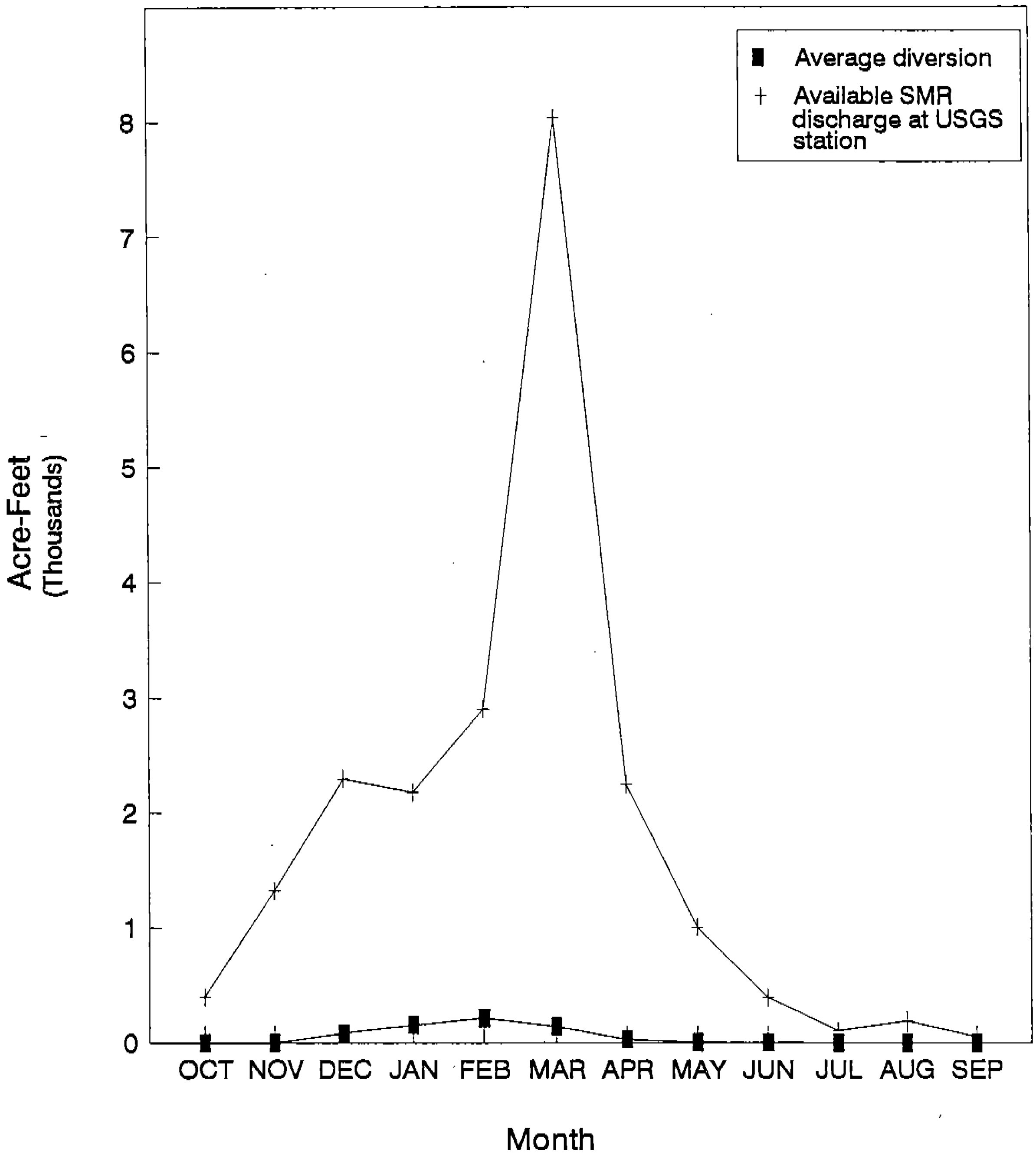


Figure 5. Average diversions of Santa Margarita River water to Lake O'Neill 1980-1990, versus water remaining in river after flows have reached the USGS discharge station down stream at Basilone Road.

through which oxygen must diffuse, activity of the fish and subsequent oxygen requirements to sustain that activity (Post, 1987) are critically important.

In 1994, D.O. concentrations measured in surface waters were near saturation at 7.3 to 11.4 ppm (Table 2). These midday D.O. levels are suitable for warmwater fish. However, subsurface D.O. levels of 2.5 to 1.8 ppm measured in September are well below saturation at the reported temperatures (23.5°C) and could lead to slowed growth, basic survival (no growth), or even death for some fish. A prolonged D.O. concentration of 1.8 ppm also has the potential to constrict the available habitat (areas with low D.O. concentrations are avoided by fish), as well as kill fish. Post (1987) lists minimum D.O. concentrations of 5.5 ppm for summer months and 4.7 ppm in winter months for survival of all individuals of largemouth bass and black crappie .

Table 1. Lake O'Neill water quality parameters tested at three sites on June 9, 1994.

Measurement	Units	#1 Top	#1 Bottom	#2 Bottom	#3 Top	#3 Bottom
Total Alkalinity	mg/L	257.00	258.00	262.00	256.00	259.00
Bicarbonate	mg/L	257.00	258.00	262.00	256.00	259.00
BOD	mg/L	<3.00	4.00	<3.00	<3.00	<3.00
COD	mg/L	33.00	26.00	24.00	46.00	20.00
Hardness	mg/L	332.00	373.00	341.00	345.00	332.00
Ammonia-Nitrogen	mg/L	0.23	0.10	0.45	<0.10	0.26
Nitrate-Nitrogen	mg/L	0.57	0.67	0.49	0.49	0.45
Nitrite-Nitrogen	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50
Chloride	mg/L	154.00	153.00	149.00	149.00	150.00
Ortho-Phosphate-P	mg/L	0.22	0.22	0.43	0.22	0.29
Total-Phosphate-P	mg/L	0.24	0.23	0.43	0.22	0.33
TDS	mg/L	698.00	682.00	643.00	671.00	677.00
Silicon	mg/L	0.80	0.91	3.12	1.85	1.51
Sulfate	mg/L	135.00	146.00	137.00	129.00	136.00
Carbon Dioxide	mg/L	7.00	7.00	12.00	7.00	10.00

BOD = Biological Oxygen Demand
COD = Chemical Oxygen Demand
TDS = Total Dissolved Solids

Table 2. Lake O'Neill basic water quality data collected in 1994.

Measurement	units	June 9 #1	June 9 #2	June 9 #3	September 26 #1	September 26 #2	September 26 #3
Sample Time:		1600	1745	1830	1400	1500	1530
Bottom Depth	(meters)	2.5	4.5	3.9	2.75	3.0	3.25
Surface Temp.	°C	24.5	24.5	25.0	24.0	24.0	24.0
1.0 m Temp.	°C	24.0	24.5	25.0	24.0	24.0	24.0
2.0 m Temp.	°C	24.0	24.5	25.0	23.5	23.5	23.5
3.0 m Temp.	°C	NA	24.5	NT	NA	23.5	23.5
Bottom Temp.	°C	24.0	24.5	23.8	23.5	23.5	23.5
Surface D.O.	mg/L	7.3	7.9	7.9	10.1	11.1	11.4
1.0 m D.O.	mg/L	7.1	7.6	NT	6.8	6.6	7.8
2.0 m D.O.	mg/L	6.9	7.6	7.6	5.4	4.5	5.0
Bottom D.O	mg/L	6.9	7.6	4.6	1.8	2.5	2.2
Sample pH	(Surface)	7.25	7.56	7.6	7.5	8.5	8.0
Sample pH	(Bottom)	6.75	7.32	NT	7.0	7.5	7.0
Conductivity	(μmho/cm)	1180					1210

NA = Not Applicable
NT = Not Taken

Swingle (1969) suggests that D.O. concentrations greater than 5 ppm are in the desirable range for warmwater species, concentrations in the 1-5 ppm range are survival levels for warmwater fish but growth is slowed with prolonged exposure. Concentrations below 1 ppm are considered lethal if exposure is prolonged. The lowest safe level for trout is approximately 5 ppm (Piper et al., 1986).

The 1994 pH levels observed in the lake ranged from 8.5 to 6.8 (Table 3) with a mean of 7.5. These pH levels are well within suitable ranges for warmwater and coldwater fish species.

The Environmental Protection Agency (EPA) recommends that the pH range be 6.5-9.0 to protect aquatic life (as quoted in MacDonald, et al., 1991). Post (1982, pers. comm.) suggests a range of 6.2 to 9.2 for fish survival. Emergence of some aquatic insects, the primary food source for smaller fish, declines below pH 6.5. MacDonald et al. (1991) also stated that a decline in pH can increase the mobility of heavy metal contamination.

Conductivity values were 1,080 and 1,210 micromhos/centimeter (μmho/cm) during 1994 sampling (Table 2). Although these values are moderately high they pose no problems for fish. However, we did encounter sampling problems, our electrofishing unit would not operate under these conductivity levels.

Post (1982, pers. comm.) suggests that waters with 150 to 1,500 μmho/cm conductivity at 25° C should have relatively good production. Boyd (1978) reports natural waters having conductivities of 20 to 1,500 μmho/cm and distilled water with a value of 1 μmho/cm. Nielsen and Johnson (1983) maintain that normal conductivities are in the range of 100-500 μmho/cm.

Crowded hatchery type conditions are waters that are most often associated with problems of high nitrogen levels. Levels of ammonia-nitrogen, nitrate-nitrogen and nitrite nitrogen in the lake averaged 0.26 mg/L, 0.53 mg/L and <0.5 mg/L respectively in 1994 (Table 1). The literature suggests that these levels of concentration are suitable for fish. However, since most nitrite values were below the level of detection (<0.5) we are unable to fully evaluate the suitability of these nitrite values for fish.

Excessive levels of ammonia can be toxic to fish but ammonia toxicity should not be a problem in natural waters with pH below 8.0 and ammonia-nitrogen less than 1.0 mg/L (Sawyer and McCarty, 1978). Piper et al. (1986) suggests healthy water supplies should have nitrate levels in the 0 to 3.0 ppm range. Nitrite-nitrogen is the most toxic form of nitrogen for fish. Piper et al. (1986) states that nitrite levels of 0.15 ppm can stress yearling trout and kills them at 0.55 ppm. They go on to say that 29 ppm nitrite can kill up to 50% of channel catfish in 48 hours.

Carbon dioxide (CO_2) levels ranged from 7.0 to 12.0 mg/L from samples taken in June 1994 (Table 1). These values are moderately high but within the acceptable range to support fish populations.

Fish can sense small differences in free CO_2 concentrations and apparently attempt to avoid areas with high CO_2 levels (Hoglund, 1961). High concentrations of CO_2 interfere with respiration (Basu, 1959). Boyd (1990) states that 10 mg/L or more of CO_2 may be tolerated, provided D.O. concentrations are high. Waters supporting good fish populations normally contained less than 5 mg/L of free CO_2 (Ellis 1937). Piper et al. (1986) suggests that CO_2 values in the range 0 to 15 mg/L are suitable for a warmwater fish hatchery water supply.

Phosphates represent important nutrients in aquatic systems and can often be a limiting factor. Total phosphate and orthophosphate levels in lake samples collected by USFWS in 1994 ranged from 0.22 to 0.43 mg/L (Table 1) with averages of 0.29 and 0.28 mg/L, respectively. Literature suggests that these values are slightly high for waters supporting fish populations. However, values are within normal concentrations for naturally occurring waters.

Piper et al. (1986) states that soluble orthophosphate concentrations are usually no greater than 5 to 20 μg/L and seldom exceed 0.1 mg/L even in highly eutrophic waters. Piper also states that concentrations of total phosphorus in natural waters seldom exceed 1 mg/L. Post (1982, pers. comm.) said that phosphate levels greater than 0.5 ppm may produce excessive plant growth. He also suggests that for waters to be productive that they should have phosphate levels greater than 0.01 ppm. Boyd (1984) recorded average values of orthophosphate and total phosphate from a sample of 34 wooded watershed ponds as 0.007 mg/L and 0.092 mg/L respectively. The U.S. EPA (1986) suggests that phosphate should not exceed 0.025 mg/L for any lake or reservoir. If streams enter the lake phosphate should not exceed 0.050 mg/L (McDonald, et al., 1991). Heavy algal blooms have been observed in lakes where phosphate concentration exceeds 0.03 mg/L (Bell, 1990).

Chemical oxygen demand (COD) is a measure of organic matter and often permits an estimation of the biological oxygen demand (BOD). BOD of pond waters results from the respiration of plankton and bacteria. Ranges of COD and BOD values from samples taken by USFWS personnel in June 1994 were 20.0 to 46.0 mg/L and <3.0 to 4.0 mg/L respectively (Table 1). These values are conducive to supporting a good fish population for an extensively managed system.

BOD values depend upon temperature, density of plankton, concentration of organic matter and related factors, but Boyd (1973b) demonstrated that a close positive correlation existed between COD and BOD. COD values ranged from 37.1 to 83.2 mg/L from May to September in two channel catfish ponds at Auburn University (Boyd et al., 1978b). A COD level of 30.2 ppm was reported for an earthen catfish rearing pond while draining (Boyd, 1978).

Total alkalinity and hardness values, in 1994, ranged from 256 to 262 mg/L and 332 to 373 mg/L (Table 2), respectively, with averages of 258 and 345 mg/L respectively. These are healthy values for a freshwater pond fishery.

Alkalinity and hardness imply similar things about water quality. Total alkalinity is the concentration of basic ions in water while hardness is the concentration of alkaline earth ions such as, calcium (Ca^{2+}), potassium (K^{+}), magnesium (Mg^{2+}), etc. Both are expressed as mg/L of calcium carbonate ($CaCO_3$). Piper et al. (1986) also states that fish grow well over a wide range of alkalinities and hardness, but values of 120-400 ppm are optimum. Natural waters that contain 40 mg/L or more total alkalinity for biological purposes are considered hard waters (Moyle, 1945; Mairs, 1966). Sawyer and McCarty (1967) categorize waters with total hardness in the range of 150-300 mg/L as hard. At very low alkalinities, water loses its ability to buffer against changes in acidity, and pH may fluctuate quickly and widely to the detriment of fish. Fish are more sensitive to some toxic pollutants at low alkalinity.

Bicarbonate (HCO_3-) combined with calcium (Ca^{2+}) form the base compound calcium carbonate ($CaCO_3$) which is the compound measured in alkalinity tests. Normally alkalinity results primarily from bicarbonate (HCO_3) and carbonate ($CO_3$$^{2-}$) ions which often combine with calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. Since bicarbonate and alkalinity are so closely related their results and analysis are essentially the same.

Total dissolved solids (TDS) measured in 1994 were 643 to 698 mg/L with an average of 674 mg/L (Table 1). Lake O'Neill is 111 years old and these results reveal an accumulation of ions in the system. The scientific literature is limited in regards to the TDS levels for warmwater fish.

However, these TDS levels for Lake O'Neill should pose no threats to warmwater fish populations.

Total dissolved solid is the total residue remaining after evaporation of a water sample which was first filtered to remove suspended matter (Post, 1982, pers. comm.). TDS concentration indicates the mg/L of dissolved organic and inorganic matter in a sample (Boyd 1984). The major cations associated with TDS are Ca^{2+}, Mg^{2+}, sodium (Na^+) and potassium (K^+). The major anions are carbonates (HCO_3 or CO_32-), chloride (Cl^-) and sulfate (SO_4^{2-}). Post (1982, pers. comm.) states that levels in the range of 5,000 to 10,000 mg/L should produce a good fishery depending on the amount of cations present.

Chloride (Cl^-) concentrations ranged from 149 to 154 mg/L in 1994 (Table 1). The 1994 values appear slightly elevated probably due to the near proximity of the ocean (approximately 5.6 km). However, these levels should support healthy fish populations.

Boyd (1990) states that Cl^- concentrations are highly variable in pond waters and may range from 1 mg/L to more than 1000 mg/L. Chloride concentrations are usually greater in waters near coasts since rainfall near oceans has high concentrations of this ion (Gorham, 1961). Post (1982, pers. comm.) states that 95% of waters in the U.S. supporting good freshwater fish populations have Cl^- concentrations less than or equal to 170 ppm.

Sulfate (SO_4^{2-}) values in 1994 ranged from 129 to 146 mg/L (Table 1) with an average of 137 mg/L. The literature is inconclusive but it appears that these values, although elevated, are normal for a pond in such close proximity to the ocean.

The most common form of sulfur in surface waters is SO_4^{2-} (Boyd, 1984). Concentrations in ponds vary with the nature of geological materials in the watershed and with hydrological conditions. In regions with waters of low salinity, concentrations of sulfate often range from 1 to 5 mg/L. However, in regions with waters of higher salinity, and particularly in arid regions, sulfate concentrations are much greater (Boyd, 1984). Post (1982, pers. comm.) suggests that water with less than 0.5 ppm sulfate will not support algae growth. He also states that most organisms are quite tolerant to sulfate. This tolerance could be due to the existence of sulfate for such a long period of time , geologically, that they have adapted to those levels. Sodium sulfate (Na_2SO_4) at 7,500 ppm for 24 days were not harmful to perch (*Percidae*) (Post, 1982, pers. comm.). Sulfate levels from 7,500 to 11,000 ppm seem to be lethal to most fish (Post, 1982, pers. comm.).

Silicon levels ranged from 0.801 to 3.12 mg/L in samples collected in 1994 (Table 2). The 1994 levels were low but should maintain a good fish population.

Silicon is required for growth of diatoms. There is evidence that in some waters silicon concentrations may regulate abundance of diatoms (Fogg, 1965). Concentrations of silicon in natural waters range from 1 to 80 mg/L (Boyd, 1990). At the pH of most inland waters, silicon is present primarily as undissociated silicic acid.

Fish Population

USFWS sampled Lake O'Neill with gill nets during the periods June 7 to 8, September 22 to 23, and September 26 to 27, 1994. The total catch consisted of 143 largemouth bass, 82 black crappie, 17 bluegill, 136 brown bullhead, 8 channel catfish, and 87 golden shiners (Figure 6). Most fish were released alive (61%) with most mortality occurring among the smaller fish (Table 3).

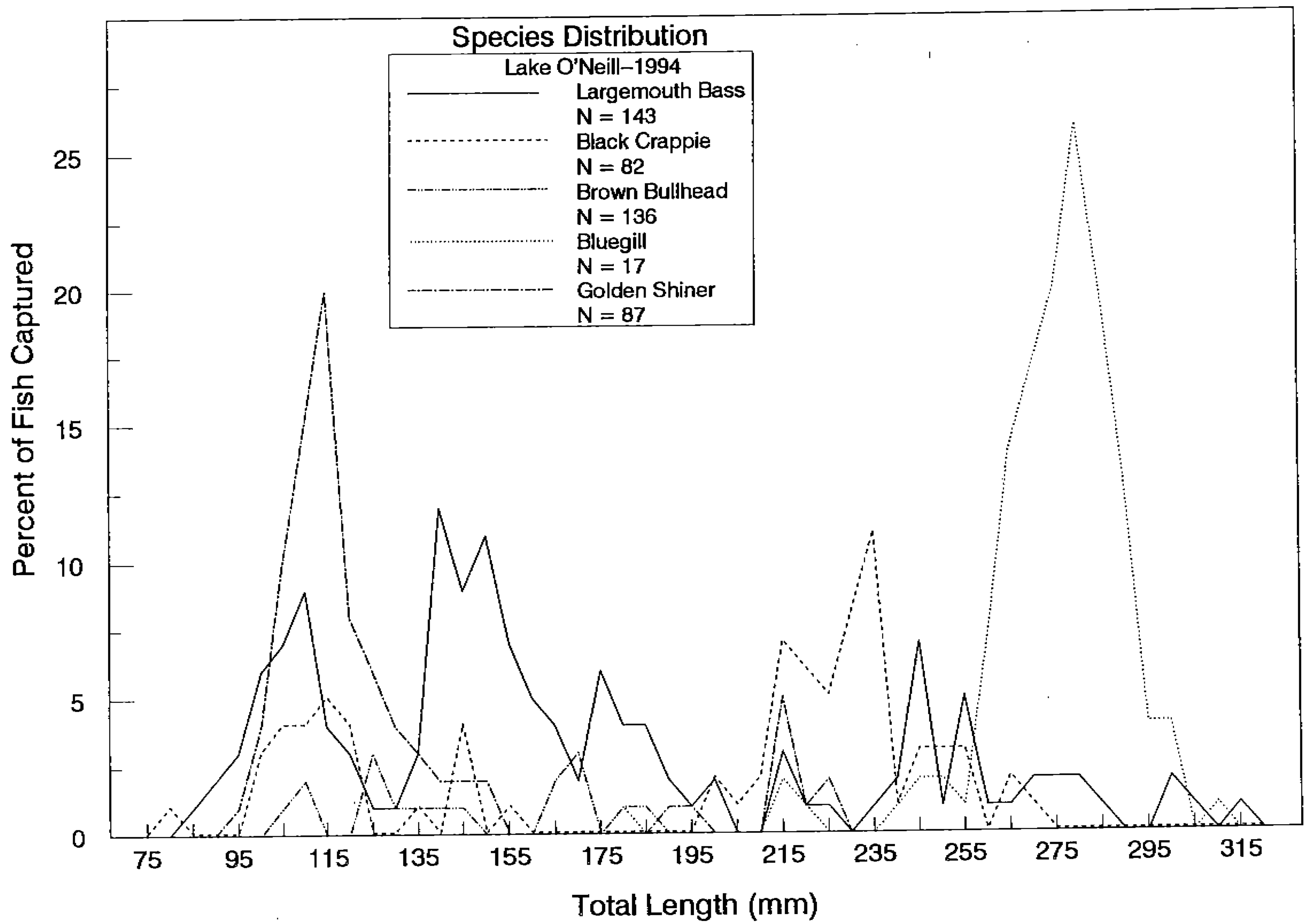


Figure 6. Length distribution by species of fish captured during Lake O'Neill sampling in June and September 1994. Channel catfish were omitted due to low sample numbers.

Table 3. Mean length and percent survival of fish captured in Lake O'Neill during 1994 sampling.

Species	No. Sampled	Mean Length (mm)	Range (mm)	Standard Deviation	% Released Alive
Largemouth bass					
June	4	182	162-211	22.8	75%
September	139	166	85-312	57.5	35%
All 1994	143	166	85-312	56.8	36%
Black crappie					
June	3	216	200-228	14.4	100%
September	79	191	78-268	56.9	62%
All 1994	82	192	78-268	56.1	63%
Bluegill					
June	3	117	106-135	15.7	0%
September	14	149	105-184	24.8	29%
All 1994	17	143	105-184	26.2	24%
Brown bullhead					
June	17	268	237-281	11.1	94%
September	119	273	176-309	17.4	87%
All 1994	136	273	176-309	16.8	88%
Channel catfish					
September	8	428	151-800	182.8	88%
Golden shiner					
September	87	126	95-225	32.9	60%

Mean lengths and associated data obtained from these fish are shown in Table 3. Length frequency histograms of species sampled in 1993 and 1994 with more than ten fish captured are shown in Figures 7 to 13. Age class determination was calculated using these length frequency histograms. Scale samples taken from each species (except catfish and brown bullhead, which lack scales), were difficult to analyze due to the relatively warm year-round temperatures and the resultant uniform growth patterns.

Age class determination of largemouth bass by length frequency patterns shown in Figure 7 indicate at least seven age classes were present. These age classes represent fish up to six years old, and is in agreement with other age class size groups identified by Davies and Rwangano (1990). They suggest that largemouth bass over 400 mm were at least eight years old. Sampling by USFWS in January 1992 indicates that even larger and older fish (390 mm) were present (Figure 8).

Our sampling of black crappie populations revealed one strong year class at age four (Figure 9). It is believed that 1994 had poor reproduction success as evidenced by a poor recruitment of age 0+ fish last year (Figure 9). It is difficult to ascertain at this time what may have been the cause of reproduction failure since black crappie obviously spawned successfully in past years. However, other age classes (one, two, and three) were also quite low in number. The annual fall drawdowns could be a cause for reproduction failure. Sampling by USFWS in January 1992 only showed one year class of black crappie (Figure 10). These fish were most likely one year old.

Bluegill age classes were fairly evenly distributed with the limited data available (Figure 11). The bluegill population was either too low for sampling or our gill nets did not effectively capture them. It is suspected

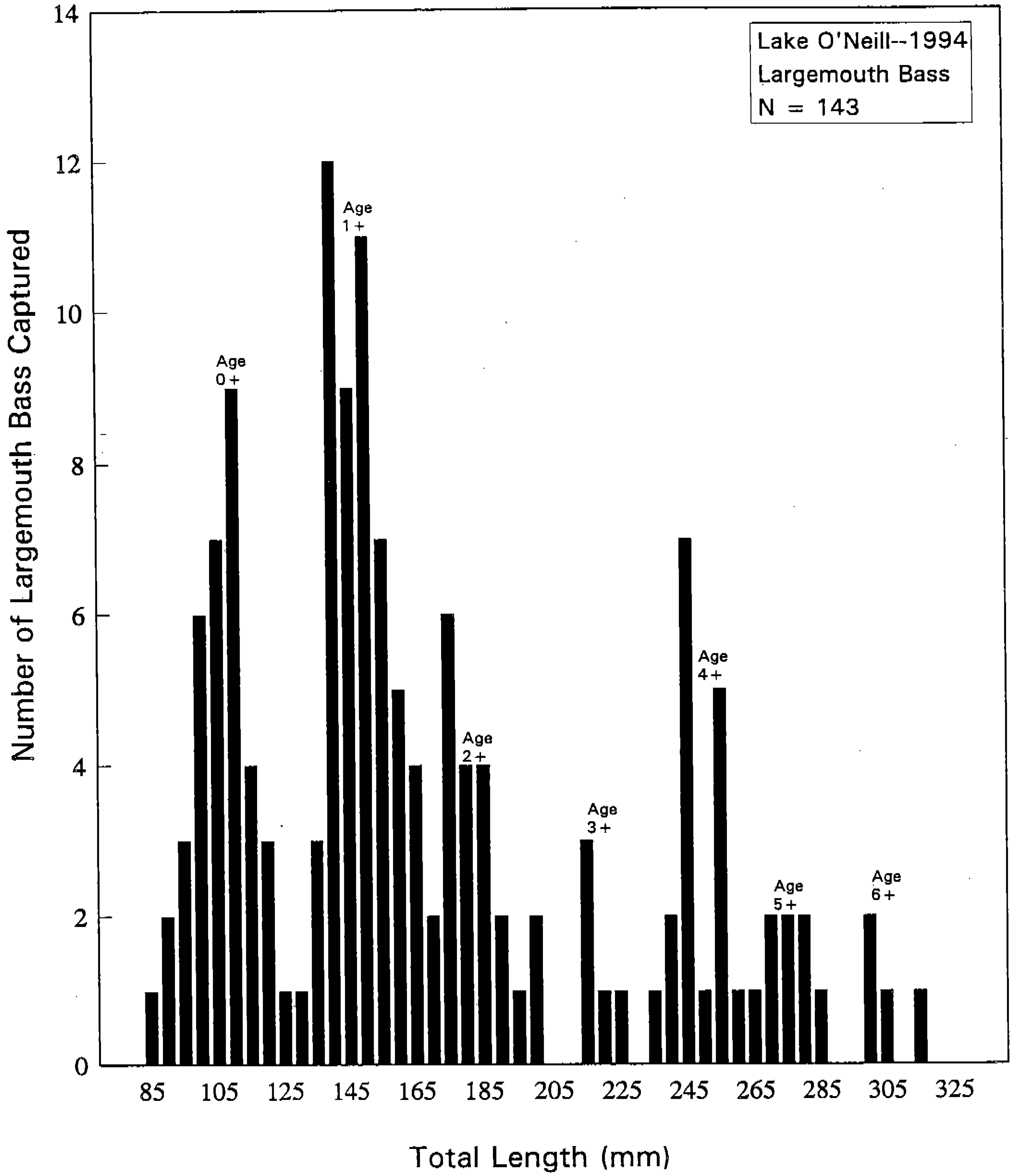
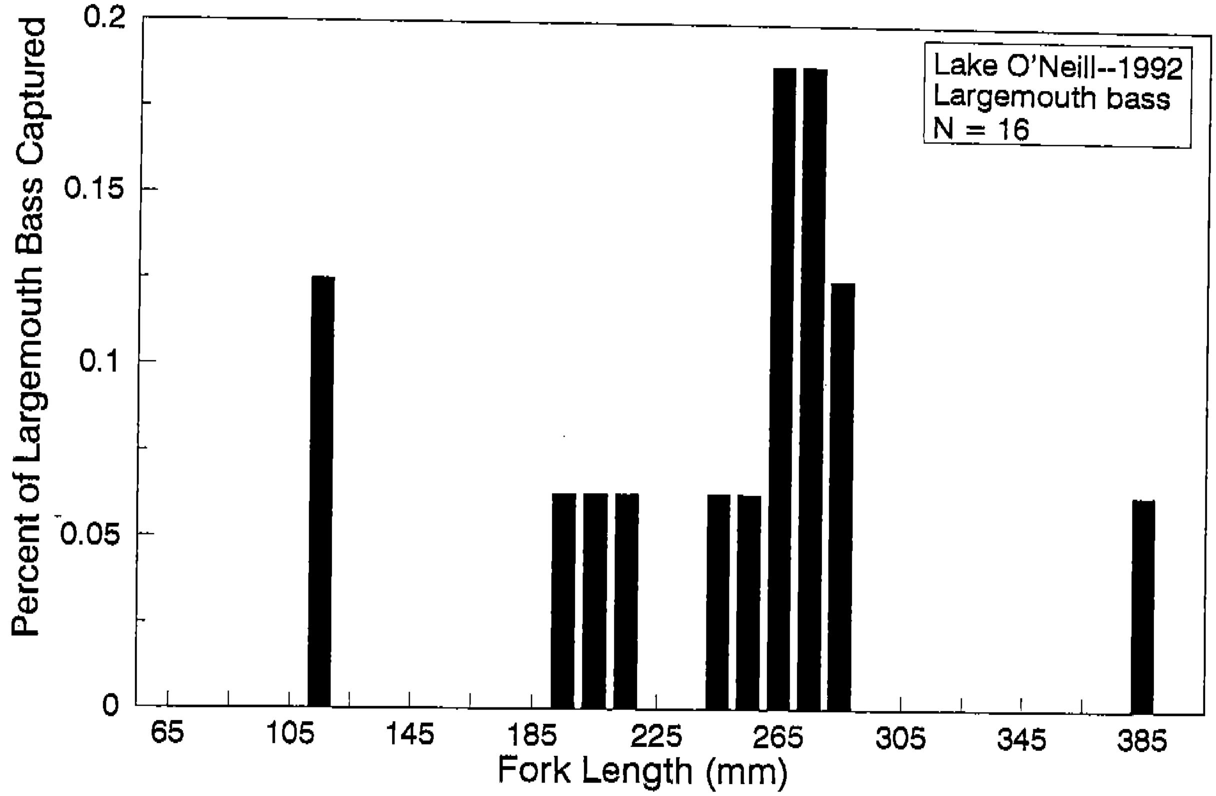


Figure 7. Length frequency histogram with associated age classes of largemouth bass captured during Lake O'Neill sampling in June and September 1994.



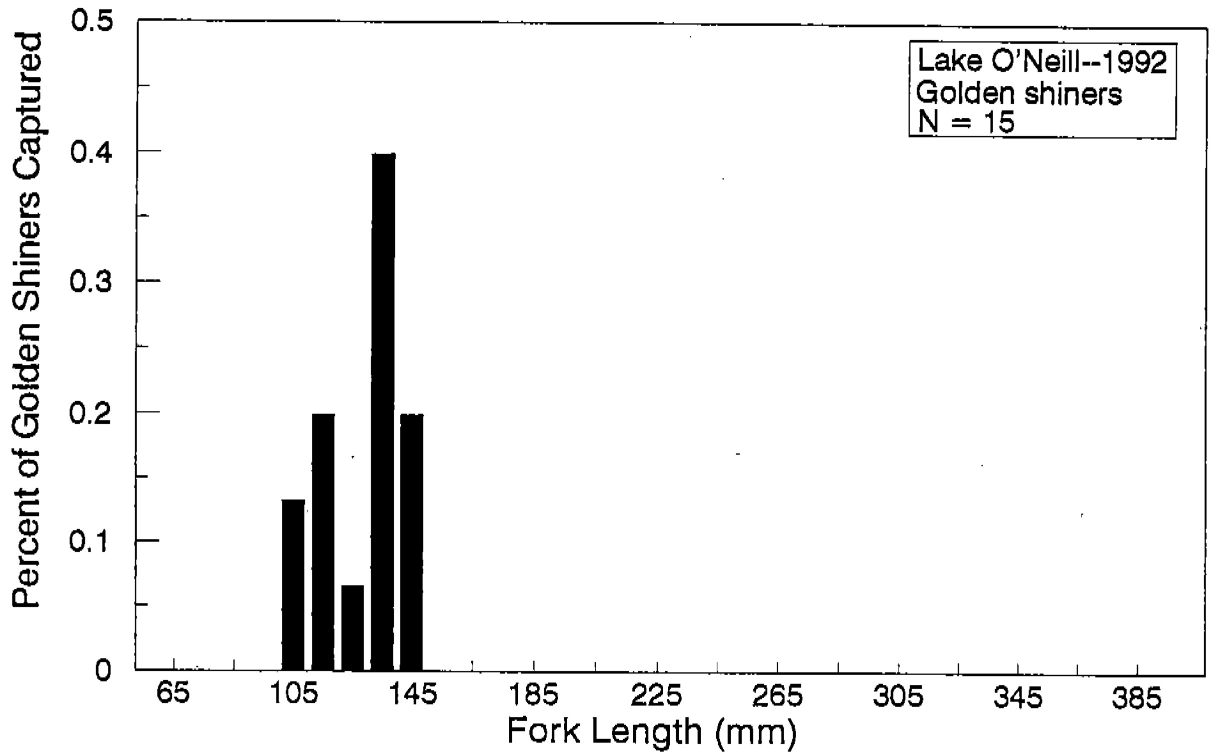


Figure 8. Length frequency histograms of largemouth bass and golden shiners captured by gill nets in Lake O'Neill during January 1992.

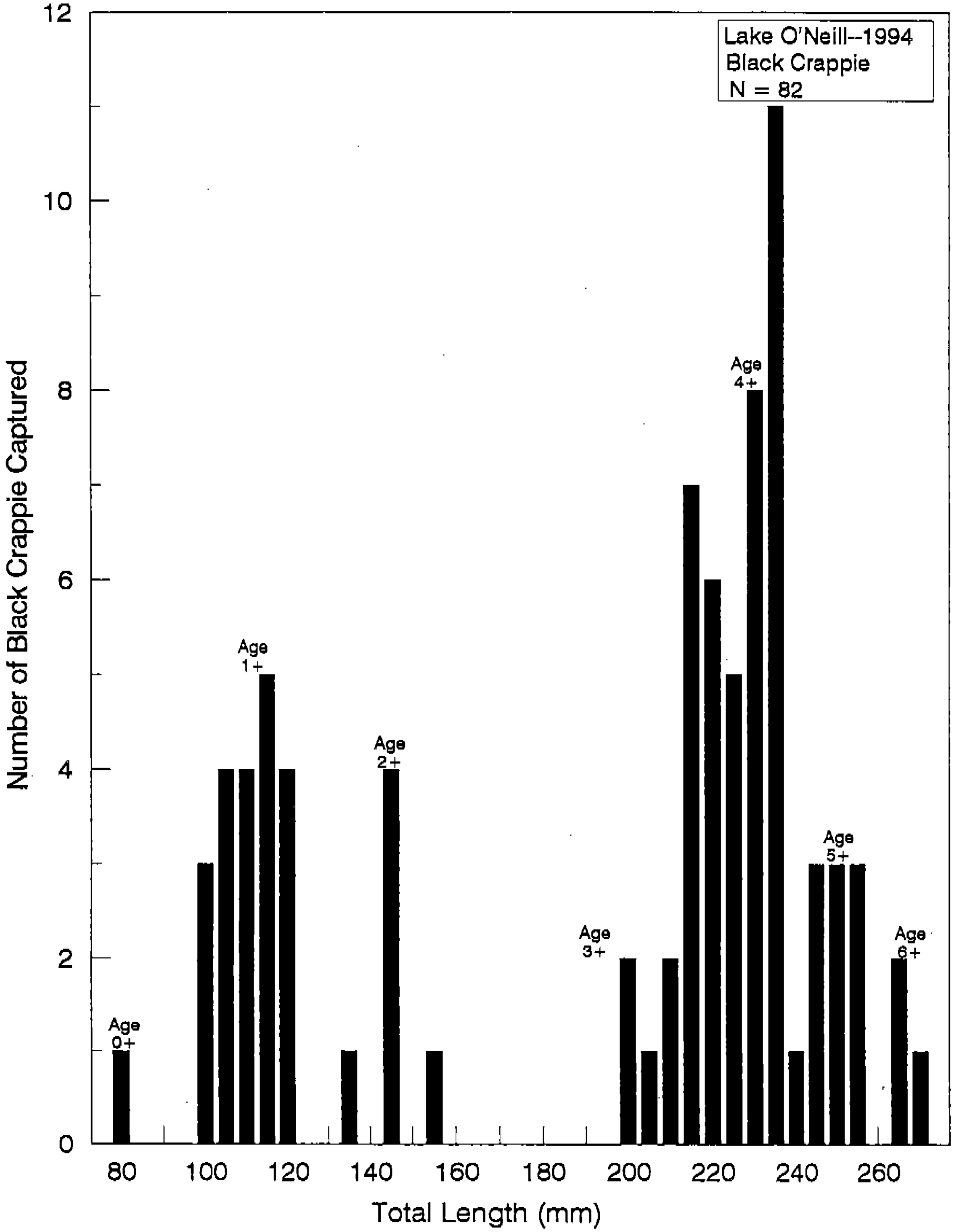


Figure 9. Length frequency histogram with associated age classes of black crappie captured during Lake O'Neill sampling in June and September 1994.

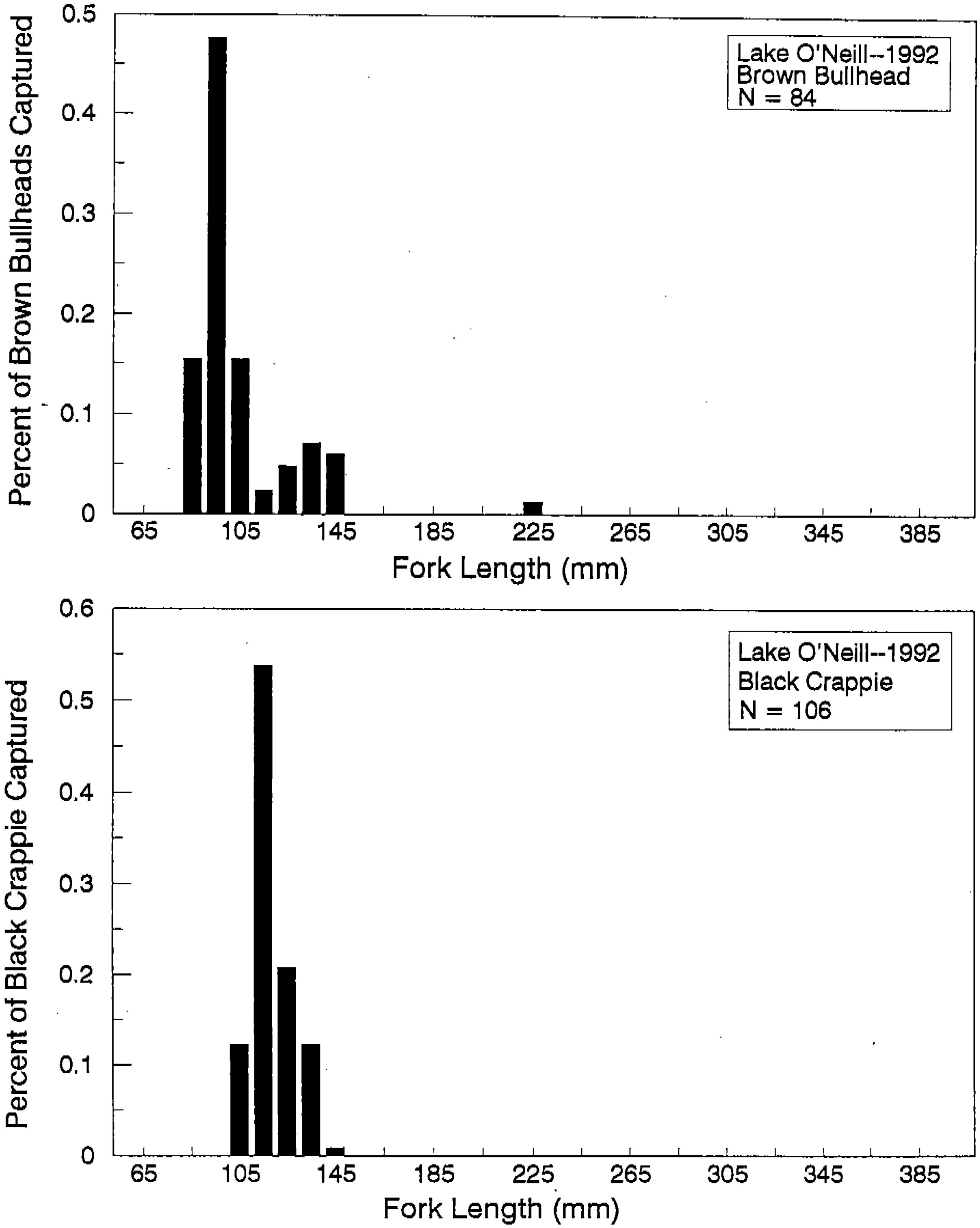


Figure 10. Length frequency histograms of brown bullhead and black crappie captured by gill nets in Lake O'Neill during January 1992

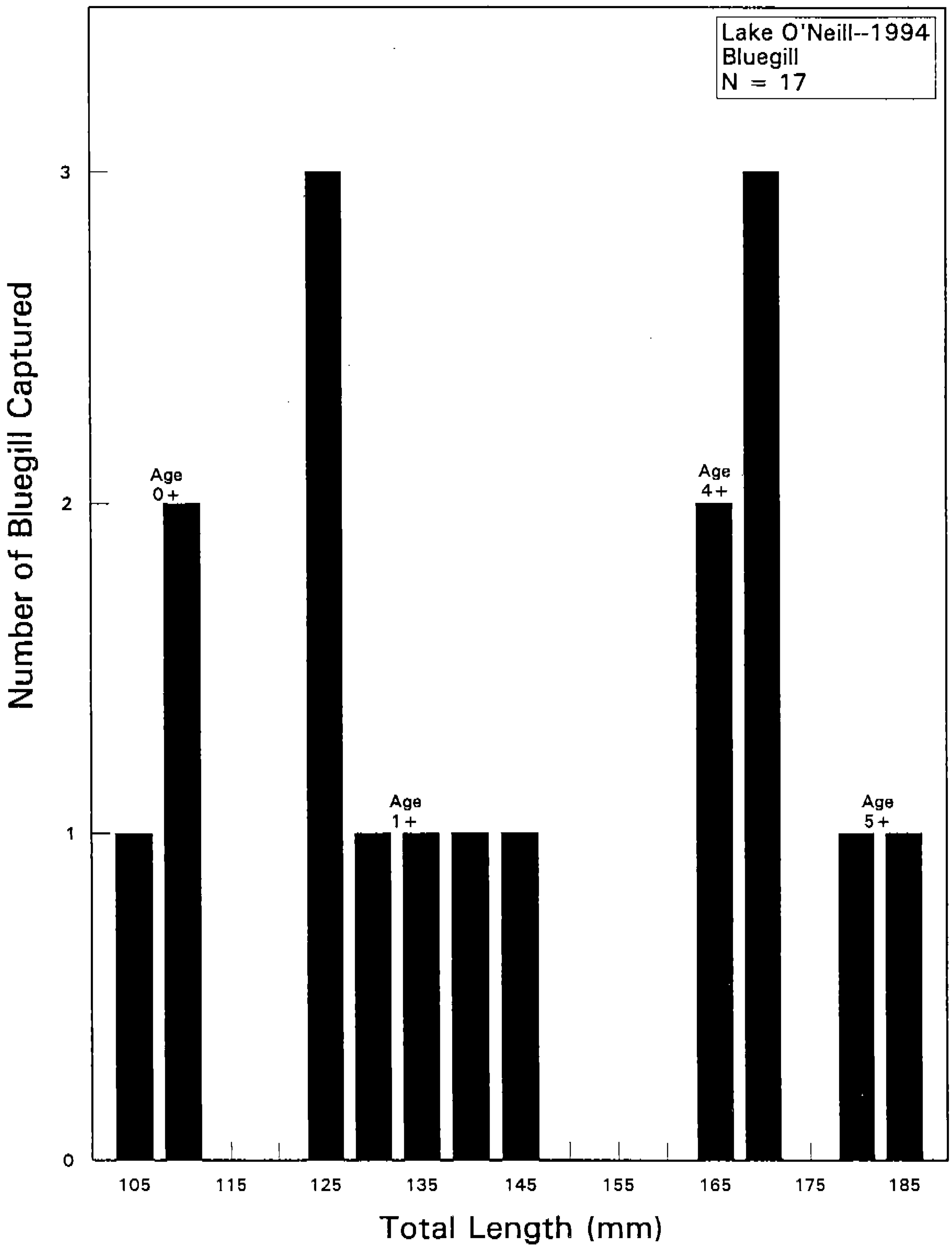


Figure 11. Length frequency histogram with associated age classes of bluegill captured during Lake O'Neill sampling in June and September 1994.

that bluegills were low in numbers. There were at least five separate age classes present, the oldest fish of which were at least five years old. This again agrees with other age class size groups identified by Davies and Rwangano (1990). They suggest that five-year old bluegill grow to a size around 185 mm. Bluegill sampled by USFWS in January 1992 were not presented in the 1993 FMP.

Brown bullhead populations were strong with fish averaging 273 mm (Table 3). Our nets did not capture many of the smaller sized bullheads which suggests that reproduction has not been very successful in past years (Figure 12). However, some spawning must be occurring since we did sample one smaller (176 mm) brown bullhead. It is possible, however, that our nets did not effectively sample the smaller sized bullhead. Most of the brown bullhead sampled by USFWS in January 1992 were smaller (80 to 150 mm) sized fish (Figure 10). This supports the possibility that our nets did not effectively sample the smaller brown bullhead in 1994.

Golden shiner populations are quite strong and well balanced as a forage species. The large numbers of small golden shiners (Figure 13) are ideal forage for predator species such as largemouth bass, larger black crappie and channel catfish. The low numbers of larger sized golden shiners is indicative that this species has not over-populated in Lake O'Neill. Golden shiners sampled in January 1992 were of the same size range (Figure 8) as those sampled in 1994 (Figure 13) suggesting a stable population.

Channel catfish we sampled were most likely fish that were stocked in previous years. Our nets captured relatively few (8) (Table 3) catfish since Lake O'Neill was recently stocked with 1,000 catchable size (0.454 kg.) catfish on September 14, 1994. Our sampling efforts did capture one trophy sized (800 mm) catfish which was most likely a survivor from previous years stocking.

The ultimate question is whether the fish populations in Lake O'Neill are stable and balanced as a "fishery community". Swingle (1969) defines a balanced fishery community as a relationship between predator and prey which provides continued good fishing of harvestable size fish. Proportional stock density (PSD) is the index most used by fishery biologists to measure the quality of warmwater fish populations. PSD represents the percent of stock-sized fish from a specific population that have attained a quality size. PSD is calculated by dividing the number of quality-size fish (Q) by the number of stock-size fish (S). A stock-size fish is one that has survived its first winter of life and is subject to the same natural mortality as adults in the population (Anderson, 1978). Quality size (total length) was established by Anderson (1978) as 300 mm, 200 mm, and 150 mm for largemouth bass, black crappie and bluegill, respectively. Anderson (1978) also proposed a stock size of 200 mm, 127 mm, and 76 mm for the three species, respectively. Using these parameters, desirable values for PSD are 40 to 60 percent for largemouth bass and 20 to 40 percent for bluegill. The reviewed literature didn't refer to a desirable PSD for black crappie. However, it is reasonable to expect a desirable PSD for black crappie to be slightly higher than for that of bluegill. We propose a desirable PSD range of 30 to 50 percent for black crappie.

The PSD for largemouth bass in 1994 was 4% in Lake O'Neill which is quite low for any bass fishery (Table 4). PSD for bluegill was 41% in 1994 which was slightly higher than desired (20 to 40%) for a bluegill fishery. However, bluegill do provide for a substantial part of the panfish fishery and should also provide for a good prey base. PSD for black crappie was 89% in 1994 which is much higher than our desirable range (30 to 50%) and indicates a disproportionate distribution with too many larger fish and too few smaller stock size fish (Table 4). Overall the fish populations in Lake O'Neill appear to be out of balance but should continue to support good fishing for bluegill and black crappie. A change of regulations to a 15" minimum size

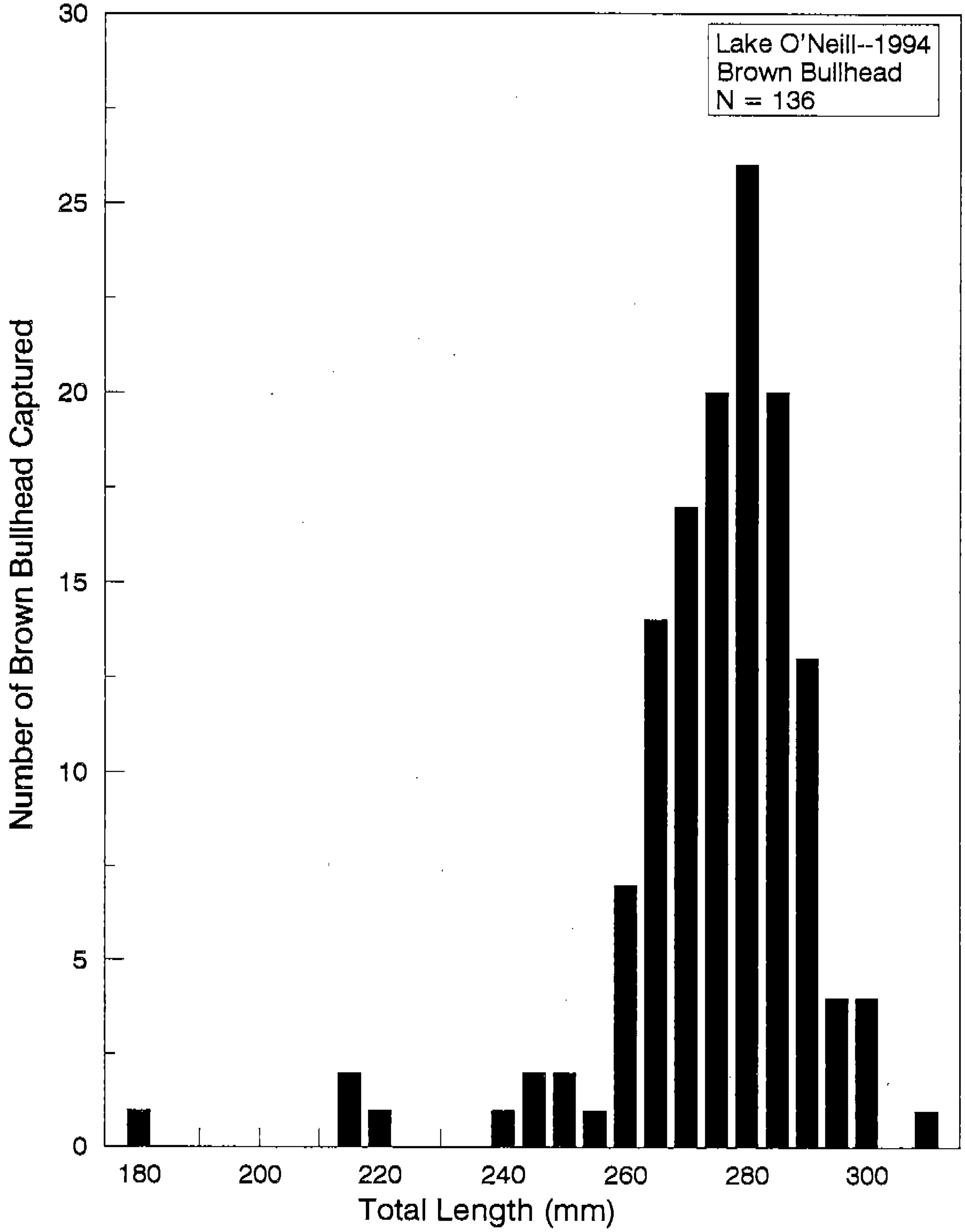


Figure 12. Length frequency histogram of brown bullhead captured in Lake in June and September 1994.

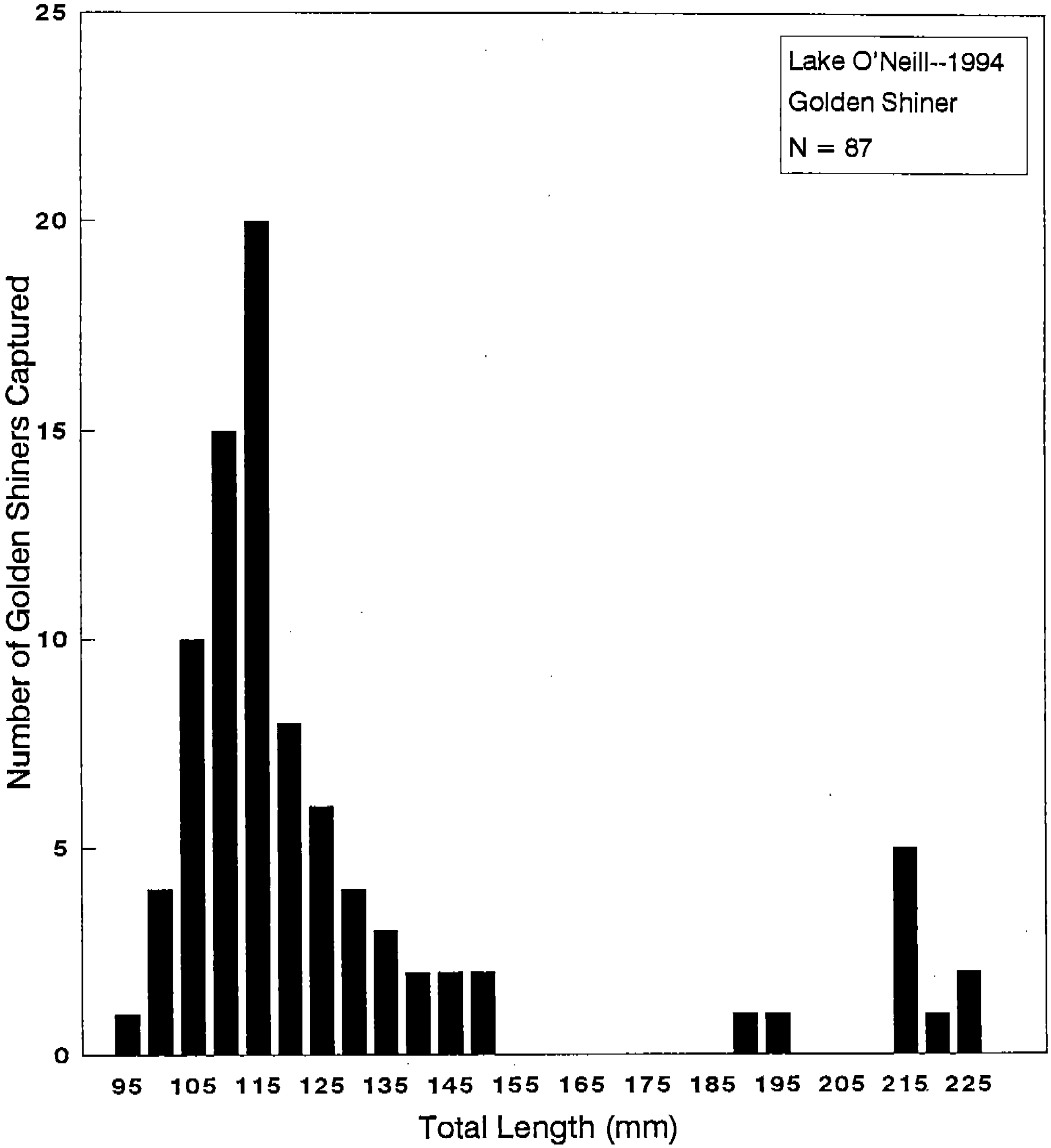


Figure 13. Length frequency histogram of golden shiners captured during Lake O'Neill sampling in June and September 1994.

limit and 2 fish/day/angler for largemouth bass would effectively help the bass population return to balance with one to two years of proper management. A change in this regulation will also help adjust the other fish populations to appropriate more balanced proportions.

Table 4. Number of stock and quality size (mm) fish and their associated proportional stock densities (PSD) in Lake O'Neill for 1994.

Species	Stock Size	Quality Size	Number of Stock size	Number of Quality size	PSD
Largemouth bass	200 mm	300 mm	52	2	4%
Bluegill	76 mm	150 mm	17	7	41%
Black crappie	127 mm	200 mm	61	54	89%

Recreational Fishery

The history of Lake O'Neill indicates it has (since at least the 1950's) always provided good fishing opportunities. A Base fishing permit and a California State fishing license are required for active duty service personnel, Base employees, retired military personnel and dependents to fish on the Base. Children, under the age of 16, may fish Base waters with a no-fee permit. State seasons and limits also apply to Base waters. There is an exception to state regulations in that the Base allows bass to be harvested at any size. A summary of Camp Pendleton fishing regulations is shown in Appendix B.

In 1994, a total of 1,800 permits were issued on the Base (Chris Stevenson, CPMCB, personal communication). Money collected through the sale of fishing permits is utilized to support Base fish and wildlife management including the purchase of fish for stocking.

Lake O'Neill fish populations have been annually supplemented with plantings of catchable size (1 fish/lb) catfish. The potential for Lake O'Neill to be managed as an all purpose (bass and panfish) fishery exists. However, if the lake is not properly managed its present status could deteriorate further.

RECOMMENDATIONS

Water Manipulation and Quality

The pattern of late fall drawdowns in Lake O'Neill as described in the 1993 FMP for Lake O'Neill is not conducive to development of healthy fish populations. There still is not a consistent drain and fill pattern in the lake.

Base records indicate as long ago as the 1960's, biologists had recommended changes in the drawdown and refill pattern for Lake O'Neill (Cates and Shaw, 1993). A 1985 memo, from Lt. Col. Grischkowsky, recommended a minimum pool of 300 acre feet and an overlap of the draining and filling period to enhance fish populations. Had the Base acted on these recommendations, the fish population and recreational value of Lake O'Neill would probably be greater at this time.

Maintaining a higher minimum pool need not interfere with the amount of water diverted from the river to maintain Base water rights. The scenario envisioned by the USFWS would include a partial drawdown to 50% of capacity, then as diversions begin from the river, releases to ground water recharge below the dam would resume (Cates and Shaw, 1993). Releases would be monitored to determine when the yearly ground water recharge needs are met. At that time, the lake would be filled. Although such a plan would require some additional flow monitoring by Base personnel, we believe it would be minimal and yield substantial benefits to the recreational values of Lake O'Neill. We believe the risk of not being able to refill the lake is minimal given the amount of water that is usually available but not utilized in the Santa Margarita River (Figure 5). Additionally, it should be recognized that the Lake O'Neill waters used for ground water recharge represent only a portion of the recharge waters and our recommendation only changes the timing of recharge and not the amounts. Many variations of possible diversion/drawdown patterns exist beyond what we suggest such as postponing the drawdown to the latest possible time period or to not drain the lake but to continue to divert allocated water and allow excess water to spill over. This would not only protect the existing fish populations, but would allow a water exchange. Base personnel more familiar with the diversion pattern can develop their own standard operating procedure with the critical features being that the lake minimum pool not be allowed below 50% of capacity and the drawdown not take place earlier than October due to the impacts of possible dissolved oxygen depletion. It is also important to have relatively stable water levels by the end of March to promote successful fish spawning and aquatic insect production.

Other advantages of a higher minimum pool include improving angler access (avoidance of crossing extensive mud flats), visual esthetics of the Base, and improving the predator/prey ratios.

A positive affect of drawdowns is that of displacing fish prey species. A drawdown would place them in close contact with predators (i.e. birds) which may be beneficial in avoiding an over abundance of prey.

Various methods can be used to reduce aquatic vegetation, should it become a problem. However, we feel that at current levels the vegetation is not a problem and provides good habitat for the fish species present. Aquatic vegetation provides valuable cover for smaller fish during their rearing years.

The decomposition of aquatic vegetation during late summer and fall may lead to oxygen depletion. This depletion can be toxic to fish and sampling needs to be continued to identify this potential problem in Lake O'Neill. If excessive oxygen depletion is noted mechanical, chemical, and biological control methods are available and can be used to counter the problem. The existence and severity of the problem can be determined, then effective counter-measures can be developed. Technical assistance from USFWS biologists and/or CDFG personnel will be available to identify to Base authorities an appropriate fish and/or aquatic vegetation control method and needed permits.

Basic water quality measurements (D.O., temperature and pH) shall be taken, at a minimum, twice a year, once in summer and once in winter. These are the simplest of measurements to obtain and the most important to gauge general water quality from one year to the next.

Although we are not aware of any contaminate problems in Lake O'Neill, it would be advisable to take samples of sediment and fish tissue for analysis (heavy metals, total petroleum hydrocarbons and PCB's) **before** encouraging intensive harvests. We were informed that hazardous items do exist in the lake by Base personnel working at the boat rental docks. These personnel reported seeing car batteries, used oil filters and empty oil containers on the lake bottom during the 1991 drawdown. This information warrants testing of various sport fish tissue samples for any possible human health concerns.

Fish Management

Warmwater fish are the most appropriate fish for management activities in Lake O'Neill. Largemouth bass are a premier sportfish in California and are present in Lake O'Neill, although their population does not appear to be well balanced. According to Base records reviewed in the 1993 FMP for Lake O'Neill, largemouth bass have the potential of growing to a large size in the lake.

In order to build up a stronger predator base and to keep down the population of crappie and other prey species, a minimum largemouth bass length limit of 38 cm (15") or greater must be established. The reasoning for this regulation would be to increase densities of bass less than 38 cm to help effectively reduce densities of overpopulated prey species. This should reduce intra-specific competition and allow prey survivors to attain sized preferred by anglers (Gablehouse, 1984). Over time this will provide a higher quality crappie, bluegill, bullhead fishery and provide a sustained fishery for large sized bass. After a few years, this size limit could be changed to a protected slot limit (30.5 to 38 cm) if the bass population is high. The small fish (< 30.5 cm) and those over 38 cm could still be harvested. In addition, adjusting the daily creel limit to 2 fish/day/angler may effectively reduce total harvest and help build better fish populations.

Black crappie are popular with fishermen because of their preference for concentrating around structures. This allows their locations to be identified by anglers and provides the opportunity to catch many fish. They are also a hardy, tolerant fish which probably explains why they are present in the lake. Given a productive environment and population control, black crappie can grow to their potential as the largest of the "panfish". They have a preference for aquatic vegetation and drawdowns of the type recommended for Lake O'Neill would help control their population by concentrating them with predators.

Channel catfish represent another significant sport species with an annual stocking program. Catfish are a popular fish in Lake O'Neill and stocking can be continued at the rate of 100 fish/acre. The catch rate of these fish, as well as others, in the lake must be monitored. Monitoring would determine if a sufficient number of channel catfish are harvested compared to the cost of stocking. Unlike the other fish present, we do not believe channel catfish will spawn successfully in the lake due to the lack of dark secluded undercut banks, logs, etc., they prefer. They offer a good trophy fishery and can survive to reach a large size (800 mm) in the lake as our sampling efforts revealed.

Brown bullheads and bluegill also represent a substantial portion of the Lake O'Neill fishery. Golden shiners and smaller bluegills are an abundant food item available for bass and other predatory species.

We believe the resident fish population could develop into a substantial recreational fishery with proper management. Once the level and timings of drawdown is reduced to 50% of capacity, bass, crappie, and other fish will do better.

Based on past data outlined in the 1993 FMP and our water quality information, the lake could support a winter/spring catchable trout fishery, probably from December into March, although we do not have good temperature data to know the exact length of favorable conditions. These fish would not survive the summer temperatures in the lake. Adding trout to the already stressed fish populations during the winter drawdown period is not advisable.

Habitat Manipulation

Largemouth bass, black crappie, and bluegill have a high preference for aquatic vegetation and underwater structures (Mosher, 1984; Reininger, 1984). This is probably not a severe problem in Lake O'Neill until the winter drawdown period. The drawdown pattern described previously leads to a lack of aquatic vegetation or other structures for fish cover at the drawdown minimum pool level. We recommend cover structures be placed in the minimum pool area to provide protection for fish and substrate for food items. These structures would also serve as focal points for fishermen. The current fisheries literature indicates evergreen tree structures provide the best combination of cover type, fish preference, angler accessibility, and cost effectiveness (Mosher, 1984; Lynch and Johnson, 1988).

Used Christmas trees have proven to be very effective structures when arranged in circles of three or more with branches overlapping 0.1 meter. Structures placed in depths of about four meters had the best results if the metalimnion (thermocline zone) was below that point (Lynch and Johnson, 1988). Even though maximum depths in Lake O'Neill will be under four meters during the drawdown, structures will be beneficial. Although the evergreen trees need to be replaced after several years (Lynch and Johnson, 1988), they are very inexpensive (tree collection after Christmas) and easy to construct. The Sport Fishing Institute has produced "Guide to the Construction of Freshwater Artificial Reefs" (Phillips, 1991), which details many inexpensive designs, mostly geared to bass, panfish, and channel catfish. A copy of this booklet is attached (Appendix C).

We believe the addition of 5-10 evergreen tree structures in the deep end of the lake may be beneficial to fish and anglers, especially during the proposed minimum pool period. Many used Christmas trees should be available on the Base and construction cost would be less than $5.00 per structure if volunteer labor is used. A concrete block is required for each tree to keep it upright on the bottom. They can not be any closer than about 50 meters from each other. It would be advantageous to have some close to shore so they can be fished by bank anglers.

It would be cost effective to encourage catfish spawning in Lake O'Neill by placing spawning containers in the lake. Catfish need a dark area to successfully spawn. These containers can easily be built of wood, or could be old plastic or metal containers. An ideal example of container size is the old fashion metal milk containers. Container size must be at least 400 mm x 400 mm x 1000 mm. Place containers at depths of 1 to 1.5 m and 10 m apart. The more containers placed in the lake the higher probability of spawning.

Fishing Access

Except for the extensively vegetated areas in the upper end of the lake, bank access at full pool appears sufficient. The two docks offer some access to deeper water, as do the boat rentals. A higher minimum pool will allow more winter access to the lake due to reduced mudflat areas. At the higher minimum pool, winter boat access might be possible.

The Base should consider building a handicap fishing dock or platform near the dam for year-round access. It can be placed close to one or more of the recommended evergreen cover structures. Lake O'Neill fishing might offer good therapy for disabled or otherwise handicapped people coming to the nearby hospital.

We recommend that boats which are allowed on Lake O'Neill be either hand or foot-propelled or powered by electric motors only. The lake is too small for any gas-powered motors which would pose serious safety concerns. Boats equipped with gas-powered motors are propelled too fast through the water for a lake the size of Lake O'Neill.

Monitoring and Program Evaluation

Although we believe our recommendations will result in a sustained quality recreational fishery in Lake O'Neill, adequate monitoring and evaluation are an essential part of any fishery management plan. An analysis of angler use and catch by Base personnel would yield valuable information concerning the status of sustainable fish populations and a cost/benefit ratio of the channel catfish stocking program. A simple census program may also identify the level of angler satisfaction with the fishery.

Several approaches are feasible to collect this data. Because the Base issues permits to fish Base waters, an opportunity exists to incorporate an angler survey form into the permit process. The data collected from the form would include; number of anglers, hours fished, fish of each species caught, fish size, type of fishing (boat vs. shore), angler satisfaction level, etc. An angler survey box could easily be constructed at the lake with a brief explanation of the purpose of the survey. This box could also provide survey forms to be filled out and a drop box for completed angler surveys.

Better information could be collected through a consistent and accurate creel census conducted throughout the fishing season. A random sampling of days during the season is acceptable if fishing days are stratified into "high use" and "low use" days (eg. weekends and holidays, vs. weekdays). The expansion, done on a weekly basis for days not covered, will be statistically accurate if the information collected for the days covered each week is complete. The more fishing days covered, the smaller the standard error and variance of the harvest estimates.

A creel checker must count the effort at regular time intervals during legal fishing hours. The time interval must be shorter than the average angler day. A two-hour interval is a good starting point. At the appropriate hour, the creel checker counts the number of people actually fishing. Separate counts for bank anglers and boat anglers are kept. For example:

1) Time interval is 2 hours. 2) Legal fishing is 6 a.m. to 8 p.m.

Count Times	Angler Count
0700	20
0900	25
1100	15
1300	5
1500	10
1700	30
1900	15
	120

120 total anglers counted x 2 hour time interval = 240 angler hours for the day.

The count for each hour represents the average effort for the hour before and the hour after the count.

During the time between the counts, the creel checker surveys the anglers. Data from "completed efforts", anglers who are finished fishing at that time, is preferred. Specific information needed is: date and time of day of interview, where did they fish (boat or bank), how many hours did each person fish (nearest 30 minutes), numbers and species of fish caught, numbers and species of fish kept, lengths of fish caught and lengths of fish kept (this is most important in the bass/bluegill/crappie fishery), and weights of fish kept. All creeled fish must be marked by the checker (caudal punch or clip). If the angler is checked again, only the time and fish caught since he resumed fishing will be counted. The creel checker should contact as many anglers as possible during this time. In the above example, if there was 120 hours of effort but only 20 hours accounted for by creel census the daily harvest estimate will have a large variance and standard error.

Catch per angler hour per day and total catch per week can be calculated from the data. This must be done for each species caught, by boat and bank angler, by keeping stratified days separate to expand for days not covered. The weekly totals can then be summed.

Biological sampling of the fish population would be another useful tool in determining if progress is being made toward management objectives. The cost and level of expertise required to effectively sample fish is minimal. In the case of Lake O'Neill, we believe passive gear, such as gill nets (similar to those used in this study), fished at alternate sites, in a specific yearly time period, and under rigid deployment specifications, can easily provide valuable fish population information. Sampling sites at various locations in the lake each spring, during May or June, is best. Relative abundance of each species and length frequencies of fish would be useful in determining if black crappie, largemouth bass, and other fish are increasing in size and/or numbers as desired. Sampling sites can be established after cover structures have been established.

Following the gill net fishing protocol described in the methods section of this report is a simple and easy method to use.

SUMMARY OF RECOMMENDATIONS

Water Manipulation:

1. Strategy 1:
   Partial drawdown to 50% capacity, then as diversions begin from the river, releases to ground water recharge below the dam would resume. Releases would be monitored to determine when and to what extent the yearly ground water recharge needs were met. Once water control needs are met the lake would be filled.

   Strategy 2:
   Postpone draining to the latest possible time period to deter predation by wildlife.

   Strategy 3:
   Do not drain the lake, but continue to divert allocated water from the Santa Margarita River and allow the excess water to spill over. This strategy would not only protect the existing fish populations, but would allow a water exchange.

2. The lake minimum pool must not be allowed below 50% of capacity and the drawdown can not take place earlier than October due to possible dissolved oxygen depletion.

Water Quality:

1. Monitoring of basic water quality is recommended twice each year, at a minimum. Base personnel must measure oxygen, pH, and temperature every summer and winter.

2. If excessive oxygen depletion is noted, mechanical, chemical, and biological control methods can be used.

3. We advise CPMCB to take samples of sediments and fish tissue for contaminant analysis (heavy metals, total petroleum hydrocarbons, PCB's). Employee's at the boat rental office at Lake O'Neill reported seeing car batteries, empty oil containers, etc. during the drawdown in 1992.

Fish Management:

1. The resident population of bass, crappie, and bluegill, along with the other species, can support a quality recreational fishery.

2. In order to maintain a sufficient predator base and to keep down the population of bluegill, golden shiners, and other prey species, a minimum largemouth bass length limit of 380 mm (15 inches) or greater must be established.

3. Adopting a daily bag limit of two fish per angler per day is recommended to spread the harvest among more anglers and prevent further depletion of the existing fish populations.

4. Stocking channel catfish (150 to 200 mm) at the rate of 100 fish/acre per year will continue to add to the recreational fishery in Lake O'Neill with little direct added competition for food.

Habitat Manipulation:

1. Submerged cover structures must be placed within easy shore access areas to provide protection for fish, substrate for food items, and increased fish abundance in areas used by bank anglers.

2. Placing 5 to 10 Christmas tree structures at the same areas used for water quality sampling would be beneficial to fish and anglers, especially bank anglers.

3. The addition of catfish spawning containers must be placed around the lake to, potentially, eliminate the need for the stocking program. The containers must be at least 10 m apart and 400 mm x 400 mm x 1000 mm in size.

Fishing Access:

1. The Base should consider building a handicap fishing dock or platform near the access area #1 for year-round access.

2. Boat access must be limited to hand propelled boats or those with electric motors only.

Monitoring and Program Evaluation:

1. Adequate monitoring and evaluating by Base personnel or USFWS are essential for a successful fishery management plan.

2. An analysis of angler use and catch by base personnel will yield valuable information concerning the status and recovery of the fish population and the cost/benefit ratio of the possible channel catfish stocking program.

3. Information could be collected through a consistent and accurate creel census conducted throughout the fishing season.

4. Biological sampling (e.g. standardized gill net sampling, seining, electrofishing) would be a simple and useful tool in determining if progress is being made toward management objectives. Sample sites must be monitored each year in May or June.

ACKNOWLEDGEMENTS

This report could not have been completed without the help and support of the U.S. Marine Corps and the Assistant chief of Staff, Environmental Security Office at Camp Pendleton. A special thank you goes to Dave Boyer, Chris Stevenson, and Rick Griffiths for background information and logistical support. Thanks are also due to Cyndie Wolfe of Coastal California Fish and Wildlife Office for her long hours of field assistance and her editing comments. Also thanks are due to Tom Kisanuki, Joe Polos and Bruce Halstead for their editing comments. I thank Carla Limond for her assistance in data entry.

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APPENDICES

APPENDIX A
Lab Methods and Water Quality Results

6-20-94

U.S. FISH AND WILDLIFE SERVICE
ANALYSES RESULTS
SAMPLE TYPE - POND WATER

ANALYSES RESULTS

ANALYSIS	PREP/ANALYSIS METHOD	UNITS	LOG NUMBER: 9849-9406 SAMPLE ID: LAKE ONEILL #1 TOP	9850-9406 LAKE ONEILL #1 BOTTOM
TOTAL ALKALINITY	STD 2320-B	MG/L	257	258
BICARBONATE	STD 2320-B	MG/L	257	258
BOD	STD 5210-B	MG/L	<3.0	4.0
COD	STD 5220-D	MG/L	33.0	26.0
ORTHO-PHOSPHATE-P	STD 4500-E	MG/L	0.22	0.22
TOTAL PHOSPHATE-P	STD 4500-B:E	MG/L	0.24	0.23
TDS	STD 2540-C	MG/L	698	682
TOTAL NITROGEN	CALC*	MG/L	<1.0	<1.0
AMMONIA-N	STD 4500-C	MG/L	0.23	0.10
NITRATE-N	EPA 300	MG/L	0.57	0.67
NITRITE-N	EPA 300	MG/L	<0.5	<0.5
TKN	STD 4500-B:C	MG/L	<1.0	<1.0
CHLORIDE	EPA 300	MG/L	154	153
SULFATE	EPA 300	MG/L	135	146
HARDNESS	3020/2340-B	MG/L	332	373
SILICON	3020/6010	MG/L	0.801	0.912

DATE EXTRACTED: 6-10-94 - BOD, HARDNESS, SILICON

DATE ANALYZED: 6-10-94 - ORTHO-PHOSPHATE-P, NITRATE-N, CHLORIDE
6-13-94 - COD, HARDNESS, SILICON
6-14-94 - TOTAL PHOSPHATE-P, TDS, AMMONIA-N
6-15-94 - TOTAL ALKALINITY, BICARBONATE, BOD, TKN
6-17-94 - TOTAL NITROGEN

* - CALCULATION BASED UPON RESULTS OF NITRATE-N, NITRITE-N, AND TKN

PETER T.L. SHEN
LABORATORY DIRECTORY

PS/dmc

QUALITY ASSURANCE
LABORATORY

6-20-94

CO_2 < 20ppm

pH - 6.5 - 8.5

Alk. 350 ... @ p...
usually 45-200

U.S. FISH AND WILDLIFE SERVICE
ANALYSES RESULTS
SAMPLE TYPE - POND WATER

ANALYSES RESULTS

ANALYSIS	PREP/ANALYSIS METHOD	UNITS	LOG NUMBER: 9851-9406 SAMPLE ID: LAKE ONEILL #2 BOTTOM	9852-9406 LAKE ONEILL #3 TOP
TOTAL ALKALINITY	STD 2320-B	MG/L	262	256
BICARBONATE	STD 2320-B	MG/L	262	256
BOD	STD 5210-B	MG/L	<3.0	<3.0
COD	STD 5220-D	MG/L	24.0	46.0
ORTHO-PHOSPHATE-P	STD 4500-E	MG/L	0.43	0.22
TOTAL PHOSPHATE-P	STD 4500-B:E	MG/L	0.43	0.22
TDS	STD 2540-C	MG/L	643	671
TOTAL NITROGEN	CALC*	MG/L	<1.0	<1.0
AMMONIA-N	STD 4500-C	MG/L	0.45	<0.10
NITRATE-N	EPA 300	MG/L	0.49	0.49
NITRITE-N	EPA 300	MG/L	<0.5	<0.5
TKN	STD 4500-B:C	MG/L	<1.0	<1.0
CHLORIDE	EPA 300	MG/L	149	149
SULFATE	EPA 300	MG/L	137	129
HARDNESS	3020/2340-B	MG/L	341	345
SILICON	3020/6010	MG/L	3.12	1.85

DATE EXTRACTED: 6-10-94 - BOD, HARDNESS, SILICON

DATE ANALYZED:
6-10-94 - ORTHO-PHOSPHATE-P, NITRATE-N, CHLORIDE
6-13-94 - COD, HARDNESS, SILICON
6-14-94 - TOTAL PHOSPHATE-P, TDS, AMMONIA-N
6-15-94 - TOTAL ALKALINITY, BICARBONATE, BOD, TKN
6-17-94 - TOTAL NITROGEN

* - CALCULATION BASED UPON RESULTS OF NITRATE-N, NITRITE-N, AND TKN

PETER T.L. SHEN
LABORATORY DIRECTORY

PS/dmc

QUALITY ASSURANCE
LABORATORY

6-20-94

U.S. FISH AND WILDLIFE SERVICE
ANALYSES RESULTS
SAMPLE TYPE - POND WATER

ANALYSES RESULTS

ANALYSIS	PREP/ANALYSIS METHOD	UNITS	LOG NUMBER: SAMPLE ID:	9853-9406 LAKE ONEILL #3 BOTTOM
TOTAL ALKALINITY	STD 2320-B	MG/L		259
BICARBONATE	STD 2320-B	MG/L		259
BOD	STD 5210-B	MG/L		<3.0
COD	STD 5220-D	MG/L		20.0
ORTHO-PHOSPHATE-P	STD 4500-E	MG/L		0.29
TOTAL PHOSPHATE-P	STD 4500-B:E	MG/L		0.33
TDS	STD 2540-C	MG/L		677
TOTAL NITROGEN	CALC*	MG/L		<1.0
AMMONIA-N	STD 4500-C	MG/L		0.26
NITRATE-N	EPA 300	MG/L		0.45
NITRITE-N	EPA 300	MG/L		<0.5
TKN	STD 4500-B:C	MG/L		<1.0
CHLORIDE	EPA 300	MG/L		150
SULFATE	EPA 300	MG/L		136
HARDNESS	3020/2340-B	MG/L		332
SILICON	3020/6010	MG/L		1.51

DATE EXTRACTED: 6-10-94 - BOD, HARDNESS, SILICON

DATE ANALYZED:
6-10-94 - ORTHO-PHOSPHATE-P, NITRATE-N, CHLORIDE
6-13-94 - COD, HARDNESS, SILICON
6-14-94 - TOTAL PHOSPHATE-P, TDS, AMMONIA-N
6-15-94 - TOTAL ALKALINITY, BICARBONATE, BOD, TKN
6-17-94 - TOTAL NITROGEN

* - CALCULATION BASED UPON RESULTS OF NITRATE-N, NITRITE-N, AND TKN

PETER T.L. SHEN
LABORATORY DIRECTORY

PS/dmc

QUALITY ASSURANCE
LABORATORY

2362

Quality Assurance Laboratory
6605 Nancy Ridge Drive
San Diego, CA 92121 (619) 552-3636

CHAIN OF CUSTODY

Date: 6/9/94 Page 1 of 1

CUSTOMER INFORMATION

COMPANY: U.S. Fish & Wildlife Service
PROJECT MANAGER: Jerry Berg
ADDRESS: 1125 16th St, Rm 209
Arcata CA 95521
PHONE: 707-822-7201
FAX: 707-822-8411

PROJECT NAME/NUMBER: Camp Pendleton

BILL TO: U.S. Fish & Wildlife Service
ADDRESS: 1125 16th St, Room 209
Arcata CA 95521
PHONE: 707-822-7201 PO #:

QA LOG #	SAMPLE ID	SAMPLE DATE	SAMPLE TIME	SAMPLE MATRIX	CONTAINER TYPE	NUMBER OF CONTAINERS	Silicon	Bicarbonate (HCO3)	BOD	COD	~~Ammonia~~	Phosphate-ORTHO	Phosphate-Total	TDS	Sulfate SO4	Formaldehyde	Ammonia-Nitrogen	Alkalinity	Chloride	Hardness			
P1-T	Pulgas L. #1 Top	6-9-94	1100	Pond water	Plastic	1	X	X						X	X	[redacted]			9845-9406				
P1-B	" " #1 Bottom		1105			1	X	X						X	X				9846				
P2-T	" " #2 Top		1115			1	X	X						X	X				9847				
P2-B	" " #2 Bottom		1117			1	X	X						X	X				9848				
01-T	Lake ONEILL #1 Top		1245			1	X	X						X	X				9849				
01-B	" " #1 Bottom		1250			1	X	X						X	X				9850				
02-B	" " #2 Bottom		1305			1	X	X						X	X				9851				
03-T	" " #3 Top		1310			1	X	X						X	X				9852				
03-B	" " #3 Bottom		1315			1	X	X	X	X	X	X	X	X	X		✓	✓	✓ 9853				
FP1-B	Pulgas #1 Bottom		1138		Glass	1	[redacted]									X	[redacted]		9854				
FP2-B	" #2 Bottom		1130			1	[redacted]									X	[redacted]		9855				

ALL PP-WORK

SAMPLE INTEGRITY

HOLDING TIME

CORRECT CONTAINER Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N

1. RELINQUISHED BY:
SIGNATURE: J. Berg DATE: 6/9/94
PRINTED NAME: Jerry Berg TIME: 15:24
COMPANY: U.S. Fish & Wildlife

1. RECEIVED BY:
SIGNATURE: TG DATE: 6/9/94
PRINTED NAME: Tania Gauchet TIME: 15:24
COMPANY: QA Lab

2. RELINQUISHED BY:
SIGNATURE: DATE:
PRINTED NAME: TIME:
COMPANY:

2. RECEIVED BY:
SIGNATURE: DATE:
PRINTED NAME: TIME:
COMPANY:

3. RELINQUISHED BY:
SIGNATURE: DATE:
PRINTED NAME: TIME:
COMPANY:

3. RECEIVED BY:
SIGNATURE: DATE:
PRINTED NAME: TIME:
COMPANY:

RECEIVED ON ICE YES / NO
TAPE SEAL INTACT YES / NO / NA
PRESERVATIVE YES / NO
PRECAUTIONS:
FAX: YES / NO
TAT REQUESTED: Normal

Ammonia Nitrogen, Alkalinity, Chloride, Hardness, client requested per phone conversation 6/10

N C. @, 16:10

— ALL SAMPLES ARE SUBJECT TO TERMS AND CONDITIONS ON REVERSE SIDE — Tom Kisanuki @ 10:40 6/10

Near Dam outlet

T + DO profile

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 6/9/94 WEATHER Clear/Sunny, breezy
COLLECTORS CW
WATER SURFACE TEMPERATURE C 24.5
STEAM/LAKE Lake O'Neill TEST LOCATION O1 O_2 meter Calibrated at ~200 ft elev

WATER PROFILE DEPTH (m)	TEMPERATURE (C)	DO(ppm)	pH	COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS
surface	24.5	7.3 mg/l	7.26	
25 ft bottom	24.0	6.9 mg/l	6.68	O_2 dail changed frequently w/ slight wind drifting
1 m	24.0	7.1		
2 m	24.0	6.9		

TEST TYPE Chloride (surface) COMMENTS:
BIOLOGIST CW
RESULTS 156 ppm

300 ft
TEST TYPE PH (surface) COMMENTS: Color change was somewhere in between the 7.0 + 7.5 standards
BIOLOGIST CW
RESULTS 7.25

TEST TYPE Am/N (surface) COMMENTS:
BIOLOGIST
RESULTS 0.2 ppm

TEST TYPE Nitrate N (surface) COMMENTS: .05 is lowest detection limit
BIOLOGIST CW
RESULTS <.05 ppm

TEST TYPE alkalinity (surf) COMMENTS: had to titrate 2x to get color change
BIOLOGIST CW
RESULTS 280 ppm

TEST TYPE CO_2 (surface) COMMENTS:
BIOLOGIST CW
RESULTS 7 ppm

TEST TYPE Hardness (surf) COMMENTS: Had to titrate twice in order to get color change
BIOLOGIST CW
RESULTS 354 ppm

TEST TYPE DO (surface) COMMENTS: used test kit to compare w/ O_2 meter
BIOLOGIST
RESULTS 7.1 ppm

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

(Continued from other side)

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 6/9/94 1620 WEATHER
COLLECTORS CW
STEAM/LAKE O Dell
WATER SURFACE TEMPERATURE C 24.5
TEST LOCATION 01 Bottom

WATER PROFILE

DEPTH (m)	TEMPERATURE (C)	DO(ppm)	pH	COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS

TEST TYPE PH (Bottom)
BIOLOGIST CW
RESULTS 6.75
COMMENTS: Sample tested somewhere between 6.5 + 7.0

TEST TYPE Ammonia Nitrogen (Bottom)
BIOLOGIST ~~CW~~ JB
RESULTS .3 ppm
COMMENTS: tested between .2 - .4 ppm

TEST TYPE Nitrate Nitrogen
BIOLOGIST
RESULTS <.05 ppm
COMMENTS:

TEST TYPE Alkalinity
BIOLOGIST CW
RESULTS 296 ppm
COMMENTS:

TEST TYPE CO_2
BIOLOGIST JB
RESULTS [illegible] ppm
COMMENTS:

TEST TYPE Chloride
BIOLOGIST CW
RESULTS 156 ppm
COMMENTS:

TEST TYPE hardness
BIOLOGIST JB
RESULTS 323
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 6/9/94 WEATHER Sunny Clear

COLLECTORS CWI

STEAM/LAKE ONeill

WATER SURFACE TEMPERATURE°C 24.5°c

TEST LOCATION 02 Near boat Ramp (in middle)

	WATER PROFILE DEPTH (m)	TEMPERATURE (C)	DO(ppm)	pH	COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS
bottom	4.5				
	3.0 m	24.5	7.6	7.32	Time 1745
	2.0 m	24.5	7.5		
	1.0 m	24.5	7.6		
surf		24.5	7.9	7.56	

TEST TYPE CO_2
BIOLOGIST Berg
RESULTS Top 7ppm Bottom 12ppm
COMMENTS:

TEST TYPE Nitrite Nitrogen
BIOLOGIST Wolfe
RESULTS Top <0.05 ppm Bottom <0.05 ppm
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
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TEST TYPE
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COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 6-9-94 1830
COLLECTORS Berg + Wolfe WEATHER Sunny
STEAM/LAKE O'Neill WATER SURFACE TEMPERATURE°C
TEST LOCATION #03

WATER PROFILE

DEPTH (m)	TEMPERATURE (C)	DO(ppm)	pH	COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS
surface	25°	7.9	7.6	
2 m	25°	7.6		
bottom ~3.9 m	~23.8	4.6		

TEST TYPE CO_2 surface
BIOLOGIST JB
RESULTS 7.0 ppm
COMMENTS:

TEST TYPE CO_2 bottom
BIOLOGIST JB
RESULTS 10.0 ppm
COMMENTS:

TEST TYPE Nitrite surface
BIOLOGIST CW
RESULTS <.05 ppm
COMMENTS:

TEST TYPE Nitrite bottom
BIOLOGIST CW
RESULTS <.05
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 9/26/94 WEATHER Cloudy, Calm
COLLECTORS C.W. WATER SURFACE TEMPERATURE°C 24°C
STEAM/LAKE O'Neill TEST LOCATION O'Neil 1

1
S.E side
ame
very algae bloom
boat ramp
2

WATER PROFILE DEPTH (m)	TEMPERATURE (C)	DO(ppm)	pH	COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS
surf	24°	10.1	6.45	~ 7.5-8.0 using test kit
1m	24°	6.8		
2m	23.5	5.4		
bottom (2.75m)	23.5°	1.8	6.18	~7.0 "
surf	24	11.1	6.61	8.5-9.0 (test kit)
1m	24	6.6		
2 m	23.5	4.5		
3m (bottom)	23.5	2.5	6.34	7.5-8.0 (test kit)

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

thick algae bloom

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 9/26/94
COLLECTORS [illegible]   WEATHER cloudy calm
STEAM/LAKE O'Neil   WATER SURFACE TEMPERATURE°C 24°
TEST LOCATION off pt on N side of boat ramp

WATER PROFILE

DEPTH (m)	TEMPERATURE (C)	DO(ppm)	pH	COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS
Surf	24	11.4	6.74	8.0 (test kit)
1m	24	7.8		
2m	23.5	5.0		
3m	23.5	2.7		
3.25m bottom	23.5	2.2	6.45	7.0-7.5 (test kit)
surf conductivity	1210			
bottom	1230			

3

1530

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

TEST TYPE
BIOLOGIST ______ COMMENTS:
RESULTS

APPENDIX B
Camp Pendleton Fishing Regulations

NATURAL RESOURCES OFFICE
Marine Corps Base
Camp Pendleton, California 92055

11015
BF5/SGB/sgd
13 Jun 84

From: Director
To: Fishermen

Subj: CAMP PENDLETON FISHING REGULATIONS

1. The following information is provided to help you have an enjoyable fishing experience. Please read it carefully. This sheet provides only a brief summary of Camp Pendleton regulations. IT IS YOUR RESPONSIBILITY TO KNOW THE CURRENT CALIFORNIA DEPARTMENT OF FISH AND GAME FISHING REGULATIONS AS WELL AS PARAGRAPH 6105 OF BASE ORDER P5000.2F.

2. Personnel Authorized Fishing Privileges

a. Active duty military stationed on Camp Pendleton, Naval Weapons Station, Fallbrook, and Camp Pendleton Mountain Warfare Training Center, Bridgeport.

b. Retired military personnel.

c. Dependents of active duty and retired military. Dependents under 12 years of age must be accompanied by an adult.

d. Bona fide house guests of active duty or retired military who are NOT house guests for the purpose of fishing.

e. Civilian employees at Camp Pendleton, Naval Weapons Station, Fallbrook, or Camp Pendleton Mountain Warfare Training Center, Bridgeport.

f. Youth Groups. Permission must be obtained from the Director, Natural Resources Office.

g. Members of the general public are authorized surf-fishing privileges within an annual quota.

MEMBERS OF THE GENERAL PUBLIC ARE NOT ALLOWED FRESHWATER FISHING PRIVILEGES ON CAMP PENDLETON.

3. Licenses. All persons 16 years of age and older shall have in their immediate possession a current California Department of Fish and Game fishing license AND a Camp Pendleton fishing permit.

4. Check-out. All persons must call the Duty Warden, 725-3360, prior to going fishing to insure that the area is open. You need not call if you wish to fish in Lake O'Neill. Checking in from fishing is not required.

5. Available Areas.

a. Freshwater inland fishing is authorized ONLY at the following locations:

Lake O'Neill
Pulgas Lake
Case Springs, Pond No. 1
Witman Pond also called Case Springs No. 2 or "Little Case"
Ysidora Basin Infiltration Ponds
Santa Margarita Rive
Santa Margarita Slough (This area is CLOSED to fishing 1 April-1 September)
Las Flores Slough-from the I-5 bridge west to the ocean. Fishing is NOT allowed in Las Flores Marsh.
Broodmare Pond commonly called "Horse Lake" (GC 705820)
Pilgrim Creek Pond (GC 715820)

With the exception of Lake O'Ne ll, all freshwater lakes are located within training areas. The availability of these areas is based on military training requirements.

b. Surf-fishing, clamming and diving for fish mollusks and crusteceans is available in the following areas:

(1) The beach area extending from the southern boundary of San Onofre State Beach to the northern bank of the Santa Margarita River. This is open to military and civilian personnel.

(2) The waterfront extending from the Santa Margarita River on the north to the northern groin of the Del Mar Boat Basin, excluding the recreation beach. This is open only to military personnel, their dependents and bona fide house guests.

(3) Fishing from the northern jetty is permitted during daylight hours only.

(4) Clamming is also permitted for military personnel on San Onofre Beach.

(5) PLEASE PAY PARTICULAR ATTENTION TO THE FOLLOWING:

(a) Access to the northern beaches is authorized only through the Aliso or Las Flores underpasses and the Stuart Mesa overpass. Parking will be authorized in posted parking areas only. Operation of private motor vehicles is prohibited westerly of Interstate 5 except en route to and from approved camping or parking areas. Foot traffic will be limited to the valley and the beach frontage only. No civilian vehicles or civilian foot traffic will be allowed on the bluff areas.

(b) Swimming or surfing is prohibited in the surf-fishing area. This, however, does not apply to licensed fishermen using underwater breathing apparatus who must display proper flags and buoy.

6. <u>Fishing hours</u>

a. Freshwater - one hour before sunrise to one hour after sunset.

b. Saltwater - Fin fish - may be taken anytime day or night.

- Marine invertebrates (clams, crabs, shrimp, lobster, etc.). Check CDFG regulations.

If an area is not being used for military training or closed for other reasons, it is available for fishing.

7. <u>Method of Take</u>

a. Freshwater - Hook and line ONLY. <u>One</u> closely attended rod and line, or <u>one</u>

hand line. Other methods are allowed for frogs and crayfish. Persons interested in taking bullfrogs and/or crayfish should consult California Fish and Game regulations on legal methods of take.

b. Saltwater - Consult CDFG regulations.

8. Species/Seasons

a. Freshwater

Species	Open-Season	Limit	Minimum Length
Black bass (includes large and small mouth bass)	All year	5	None
Trout	All year	5	None
Crappie, Sunfish (includes Bluegill)	All year	None	None
Catfish	All year	20	None
Bullhead	All year	None	None
Bullfrog	1 July - 30 Nov	12	None
Crayfish	All year	None	None

b. Saltwater. The variety of fin fish and marine invertebrates (clams, crab, shrimp, lobster etc.) available off Camp Pendleton are too numerous to list here. Anglers should consult current CDFG regulations for information on season length, limit, minimum length and methods of take

9. Violations. It is illegal to do any of the following. If observed by a Game Warden, you will be ISSUED A CITATION. Numbers in parenthesis refer to Title 14, California Administrative Code.

Fishing without a valid California fishing license in your immediate possession (700.0).

Refusal to show fishing licenses, fishing equipment or fish on demand. Fish and Game Code, Sec 2012

Freshwater fishing with more than one pole in the water (2.05).

Fishing with methods other than hook and line (1.14).

Having or attempting to take over the daily bag and possession limit (1.17).

Freshwater fishing at night (3.00).

Use of lights to take fin fish (2.15).

PAUL L. V. CAMPO

1994 FISHERY MANAGEMENT PLAN

UPDATE FOR LAKE O'NEILL

CAMP PENDLETON, CALIFORNIA

PREPARED FOR:

ASSISTANT CHIEF OF STAFF, ENVIRONMENTAL SECURITY
ENVIRONMENTAL AND NATURAL RESOURCES OFFICE
MARINE CORPS BASE
CAMP PENDLETON

PREPARED BY:

Jerry D. Berg, Fishery Biologist

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE
COASTAL CALIFORNIA FISH AND WILDLIFE OFFICE
ARCATA, CALIFORNIA

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